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ENGINEERING NEWS-RECORD

APRIL 10, 1941

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Chrysler engineers planning the building layout and production lines for turning out five 25-ton tanks per day.

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WALDO G. BOWMAN, *Editor* • ALBERT E. PAXTON, *Manager*

Vol. 126 APRIL 10, 1941 No. 15

THIS WEEK

• A plant designed to turn out five 25-ton tanks per day has been built by Chrysler, and the article reviewing the project indicates the variety of engineering work required for this type of industrial development.

• At Camp Wallace, near Hitchcock, Tex., the contractor on cantonment construction resorted to plank roads and a planked-over area for timber working in his struggle against almost impossible mud conditions.

• Unusual forms of cantilever design are in use at Friant Dam, on the Central Valley Project, and the design of these forms provides information adding a new chapter to construction procedure using mass concrete.

• In the West there has been established a substantial municipal precedent for financing refuse collection by direct service charges rather than by taxation. Examples of this practice are reviewed with data on costs.

• Borrowing a relatively new material from the highway field, the engineers on the Army's Westover Field in Massachusetts have used soil-cement for runways, and the project has developed new procedure for mixing and a method of top enrichment.

ANNUAL COST BOOK

April 24

• Combined with the regular editorial content of the April 24 issue will be the comprehensive section presenting the *Engineering News-Record* annual review of construction costs. Bound in with the issue, this cost yearbook goes free to all subscribers and brings them a wide range of price trends, statistics and unit bid tabulations.

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The Week In Engineering and Construction

ENGINEERING NEWS-RECORD • APRIL 10, 1941

New power is granted FHA to handle defense housing

Legislation includes a special $100,000,000 FHA home mortgage insurance authorization and provides machinery enabling private enterprise to supply upwards of 25,000 units

With President Roosevelt's signature on amendments to the National Housing Act, creating Title VI, the Federal Housing Administration is now prepared to further the construction of homes in specified defense areas, it has been announced by FHA Administrator Abner H. Ferguson.

The legislation sets up a special $100,000,000 FHA home mortgage insurance authorization and provides machinery enabling private enterprise to supply upwards of 25,000 housing units.

A defense housing insurance fund of not more than $10,000,000 will be made available to FHA by the Reconstruction Finance Corporation. Mortgages insured under the new title will be distinct from those insured under Section 203 of the act, constituting the bulk of FHA's operations, and will have no claim upon the assets of insurance reserves which have been accumulated.

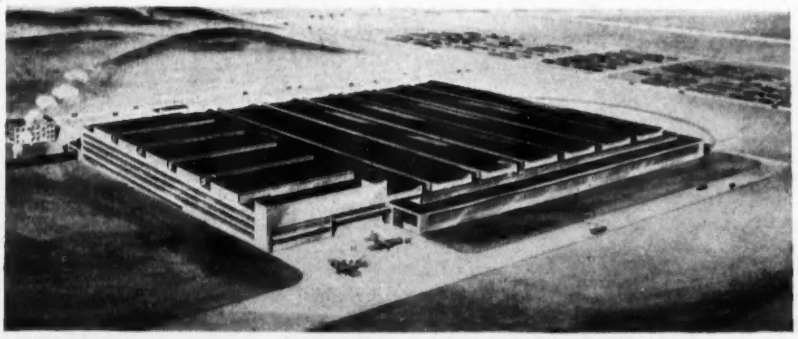
Special characteristics of mortgage insurance under Title VI include the following: (1) It will be restricted to areas "in which the President shall find that an acute shortage of housing exists or impends which would impede national defense activities," and will be limited to insurance commitments entered into on or before July 1, 1942, unless President Roosevelt should declare the emergency terminated prior to that date; (2) in contrast to the provisions of Section 203 limiting 90-percent mortgages to owner-occupied new homes, the new title authorizes insurance of mortgages of up to 90 percent of FHA valuation of new properties in cases where the builder is the mortgagor; the builder may thereafter either rent or sell subject to the insured mortgage; (3) mortgages insured under Title VI will have a maximum term of 20 years; (4) mortgages will be limited to a maximum of $4,000 on a single-family home, $6,000 on a two-family home, $8,000 on a three-family home, and $10,500 on a four-family home; and (5) mortgages eligible for insurance under Title VI are limited to those on new dwellings on which construction was started after Jan. 1, 1940, and which were approved for mortgage insurance or for defense-housing insurance prior to the beginning of construction.

Federal rights expanded along navigable streams

Structures built within the ordinary high water limits of a navigable stream are placed there at the risk of the owner and may be injured or destroyed by the federal government without compensation in connection with improvements to the navigability of the stream. This principle does not depend upon whether the structures actually interfere with navigation. The U. S. Supreme Court so decided on March 31 in reversing a lower court decision and remanding for further testimony a case which had been instituted by the Chicago, Milwaukee, St. Paul and Pacific R. R.

Certain of the railroad's lines in Minnesota run on an embankment alongside the Mississippi River. When the level of the river was raised in connection with canalization of the upper Mississippi, the embankment was injured, and the

(*Continued on p. 32*)



How the bomber assembly plant at Omaha will look

Ground was broken March 3 for the government-owned bomber assembly plant at Fort Crook, Neb. (near Omaha), in which the Glenn L. Martin Co. will turn out its B-26 medium bombers. One of four such plants to which automobile companies will send bomber parts for assembly (the others being for North American Aviation at Kansas City, Kans., for Consolidated Aircraft at Fort Worth, Texas, and for Douglas Aircraft at Tulsa, Okla.), the Omaha plant is very similar in design to recent additions made to the Martin main plant at Baltimore (see ENR June 22, 1939, p. 842, for details; also March 27, 1941, p. 453).

The Omaha plant, shown here in an architectural rendering, is 600 x 900 ft. in plan and two stories high. Reinforced concrete is used for the basement and for the flat slab first floor, while the superstructure is structural steel. Basement bays are 25 x 25 ft., and first floor bays are 50 x 100, except in the final assembly bay (left) which has a 200 ft. clear span.

In addition to the building shown, the project includes two 400 x 150-ft. hangars, a power plant, several small buildings, three 300-ft. wide runways, and two parking lots for the 6,000 employees. Completion is expected in seven months. The plant was designed by Albert Kahn Associated Architects and Engineers, Inc., Detroit. Contractors are Peter Kiewit Sons Co. and George W. Condon of Omaha, and Woods Brothers Const. Co. of Lincoln.

Photo by Studev Co.

San Antonio completes first USHA project for Mexicans

Alazan Courts, a $4,000,000 housing project, has been completed at San Antonio, Texas, under USHA for the city's Mexican population.

Containing 932 family units of 2, 3 and 4 room apartments, the buildings are concrete and hollow tile construction with stucco exterior walls, steel window casements and door frames. Approximately 75 percent are of one-story height and 25 percent two-stories high; the group covering an area of approximately 60 acres.

Apache Courts, a 248-family unit project, is now under construction as an extension to Alazan Courts, and erection cost is estimated at about $1,116,000.

McKenzie Construction Co., were general contractors for the Alazan Court project, and the firm of Atlee B. & R. M. Ayres; Phelps, DeWees & Simmons, and N. Straus Mayfach, architects. The engineer was J. W. Beretta Engineers, Inc. On the Apache Courts job, Walsh & Burney Co. are contractors, and this structure was designed by the same group of architects as Alazan Court; with the addition of Gordon M. Smith. J. W. Beretta Engineers, Inc., are also handling Apache Courts job.

Chicago denied temporary lake diversion increase

Dismissal of the petition of the State of Illinois for a temporary increase in the amount of water diversion from Lake Michigan through the Chicago Drainage Canal has been recommended by Special Master Monte M. Lemann to the U. S. Supreme Court. The state claims the present diversion, 1,500 c.f.s. set by a Supreme Court order effective Jan. 1, 1939, is insufficient to prevent an obnoxious condition in the canal and Illinois River created by Chicago sewage. The petition asked for "an increase of enough water, in addition to the 1,500 c.f.s. already allowed, during the summer months of 1941 and 1942 to maintain a minimum of 1 p.p.m. oxygen in Brandon Road Pool," on the Illinois River just below Joliet. The petition further specified the additional diversion would be held to a maximum annual average increase of 2,000 c.f.s. in 1941 and 1,250 c.f.s. in 1942. In 1941 the maximum increased diversion would be distributed as follows: May, 1,000 c.f.s.; June, 6,000 c.f.s.; July, 5,000 c.f.s.; August, 4000 c.f.s. and Sept., 1,000 c.f.s. The amounts would be correspondingly lower in 1942. By 1943 the addition to the Southwest Side sewage plant, now being built by the Sanitary District of Chicago, will be completed, and full treatment of sewage from the city and 60 suburban communities will be possible.

The report of the special master states "the actual condition of the Illinois waterway creates in the summer months, a nuisance through offensive odors at Joliet and Lockport, but does not present a menace to health." Attorney General George F. Barrett of Illinois has announced he will file exceptions to the report.

• • •

Oklahoma City settles water works bond issue

Long litigation over water works bonds in the sum of $6,911,000 which has prevented Oklahoma City, Okla., from disposing of the bonds voted by taxpayers on Feb. 20, 1940, has finally been cleared, which now leaves the city free to employ engineers and proceed with its construction work.

The firm of V. V. Long & Co., local consulting engineers, has been selected to design and supervise the construction of the Bluff Creek reservoir, the filtration plant and canal in the city's water supply improvement program. The city water department will design and supervise the construction of the improvements of the existing Lake Overholser and the water distribution system.

It is expected that a board of consultants selected from outside Oklahoma will review all the plans and specifications as prepared for the work and make periodic inspections. These men have not yet been announced. Oklahoma City now has a four month supply of water in the resorvoir and the new improvements are urgently needed. It is expected that construction will get under way early this summer.

• • •

Lake Washington Bridge tolls exceed estimate

The Washington State Toll Bridge Authority announces that revenue from tolls collected from the Lake Washington pontoon bridge at Seattle, to date, has exceeded original estimates.

Since the bridge was opened last July, it has been used by an average of 3,468 cars daily and total collections so far amounted to $294,499.

Work started on first section of Madera Canal

Work has been started at Friant Dam on the first link of the Madera Canal, a $400,000 contract having recently been let to Utah Construction Co., which calls for construction of the first ten miles of the 38 mi. canal which, when completed, will deliver Friant water to a point near Chowchilla on the Chowchilla River.

As outlined by R. B. Williams, engineer in charge of the Friant unit of the Central Valley Project for the U. S. Bureau of Reclamation, the initial work will involve excavation, concrete lining and construction of operating works, including three siphons under Cottonwood Creek and two other minor streams.

The first ten miles of work will advance the canal from Friant to a point northward near the Yosemite highway.

Sanitation problems are acute in national defense areas

Expenditure of $83,000,000 for water and sewage facilities is estimated by Public Health Service to meet needs in congested civilian centers around Army camps and defense industries.

Sanitary engineers received an unofficial call to arms on April 2 when Army, Navy and Public Health Service officers detailed some of the sanitation problems growing out of national defense activities before a joint meeting of the New England Water Works Association, the New England Sewage Works Association and the New England Health Institute in Boston.

The major challenge, as outlined by Ralph E. Tarbett, chief sanitary engineer of the U. S. Public Health Service, is to provide necessary facilities for health maintenance in the areas surrounding camps and new defense industries. He pointed out that in the 73 military camps and 30 industrial plant areas established for defense purposes there is immediate need for an estimated expenditure of $28,000,000 for waterworks and $45,000,000 for sewage disposal; properly trained men, as well as money, said Tarbett, are required to expedite this program.

Added emphasis to the serious situation outlined by Mr. Tarbett is to be found in a statement to the Health Institute from Surgeon-General Thomas A. Parran of the U.S.P.H.S. who said that sanitation problems near certain defense areas were more acute than some of those he had seen in Europe.

Navy needs sanitarians

News to many was the statement by Capt. Joseph J. A. McMullen, representing the Surgeon-General of the Navy, who pointed to the pressing need for sanitary engineers in the public health division of the Navy department. Capt. McMullen said that a big expansion in the sanitary personnel of the Navy was under way, especially to fill posts at Caribbean bases.

Sanitation activities in the Army were discussed by Colonel J. J. Reddy, representing the Surgeon-General, U. S. Army, and by Col. W. A. Hardenbergh, chief engineer of the Army Sanitary Corps. An article scheduled for the April 24 issue of *Engineering News-Record* will give the details of the Sanitary Corps and its work.

Other speakers on the program included Prof. W. L. Mallmann, Michigan State College and Dr. L. T. Fairhall, principal industrial toxicologist, National Institute of Health, both of whom discussed water purity; Samuel M. Ellsworth, consulting engineer, Boston, who told how the Camp Edwards water supply and sewage disposal facilities were built in 4½ months; W. W. Brush, editor of *Water Works Engineering*, who spoke on emergency protection of water supplies; and W. T. Tiedeman, New York State Department of Health, who outlined sanitary problems in the vicinity of troop areas.

• • •

Bill in Texas legislature to end river pollution

A bill aimed to end both sanitary and industrial pollution of Texas rivers has been presented to the State legislature by Representative Fred V. Klingeman. The measure would broaden existing laws against stream pollution and would aid enforcement by the State Department of Public Health and the Attorney General by defining pollution in bacteriological and chemical terms.

Some of the larger Texas rivers have been severely polluted because of inadequately treated city sewage and wastes from oil fields and industrial plants. It is said that in no part of the country is there a similar condition.

Photo by Chicago Architectural Photo Co.

Chicago filtration plant tunnels get final inspection

Two 16-ft tunnels, aggregating 10,000 ft. in length, to serve the South District water filtration plant in Chicago, have been completed by Wenzel & Henoch Company, contractors of Milwaukee. The tunnels were driven both ways from a shaft and cross drift at 75th St. and the lake. Completion of the tunnels was the occasion of an inspection by a large group of city and federal officials and contractors. Included in the above group are: (1) James J. Versluis, engineer of waterworks construction, Chicago; (2) Loran D. Gayton, assistant city engineer; (3) W. W. DeBerard, city engineer; (4) L. J. Ruddock, resident engineer inspector in charge for PWA; (5) Otto Seefeld, vice president of Wenzel & Henoch; (6) O. D. Carlyle, engineer of waterworks design, Chicago; and (7) E. F. Henoch, secretary and treasurer, Wenzel & Henoch. Walter J. Hoenecke, general superintendent for the contractors on the job ducked out of the picture.

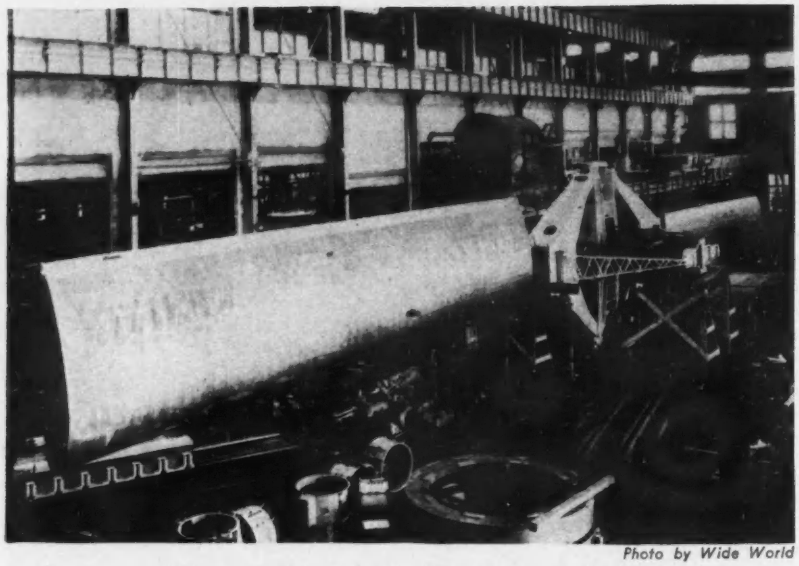


Photo by Wide World

Wind turbine built for power study

A large scale research project in which modern knowledge of aerodynamics will be applied to power development is under construction on the summit of Grandpa's Knob in the Green Mountain near Rutland, Vt. Here shown is the turbine propeller under construction in a shop of the Wellman Engineering Co., Cleveland. It has a length of 175 ft. and weighs 20 tons. The propeller and power unit, having a total weight of 75 tons, now is being installed on a 110-ft. tower; it is hoped to have the unit in operation by July 1.

The propelling unit is a radical departure from those of old-fashioned windmills. Its two blades are designed like the wings of an airplane, the thick end being turned into the wind to use the negative pressure developed by the flow of air over the blade to propel the blades. The blades can be rotated about their long axis, much as the blades of a Kaplan turbine are rotated, and can tip back several degrees under sudden gusts of wind. The propeller rotates at 28.5 rpm., and gears raise this to 600 rpm. at the generator. All the mechanical units are mounted on a revolving platform.

This wind turbine is expected to develop 1,000 kw. It will be used to determine the feasibility of applying modern aerodynamic knowledge to conversion of wind power into electric energy and if successful will be used as the basis for the design of other wind turbines. The present designs were made by P. C. Putnam, Boston, who is acting as project engineer for the sponsors, the S. Morgan Smith Co., and the General Electric Co. The American Bridge Co. built the tower.

Consultants resign under new QM policy

Engineers who are members of firms holding contracts with the construction division of the Quartermaster Corps will not be retained as consultants or employed by the division, under a new policy instituted late last month. As a result of this policy three consultants to the engineering section of the division, who preferred not to sever their firm connections, have resigned. They are Samuel A. Greeley and Thomas N. Niles of the firm of Greeley & Hansen and E. B. Black of the firm of Black & Veatch. It is understood that Earnest Boyce, chief engineer, Kansas State Board of Health and professor of civil engineering at the University of Kansas has been appointed to take Mr. Black's place as head of the water engineering section.

Another resignation is that of Francis Blossom of Sanderson & Porter from the construction advisory committee. Richard Henry Tatlow, 3rd, formerly with Harrington & Cortelyou of Kansas City has been appointed Mr. Blossom's successor.

Resignation of Greeley and Niles has no effect on the retainer of the firm of Greeley & Hansen, along with Metcalf & Eddy, as general consultants on cantonment water and sewage. They had been retained individually on a different assignment. Mr. Greeley retains his connection with the group of engineers working on problems of civilian protection, which is associated with the Corps of Engineers. Similarly, the rule is not being interpreted to cover men connected with firms having contracts with other branches of the War Department.

It is understood that there have also been a number of resignations among the field staff as a result of the new policy; one that is known is Enoch R. Needles of the firm of Howard, Needles, Tammen & Bergendoff, who has been serving as engineer of Zone 2 at New York, and it is to be expected that as Quartermaster contracts are let to new firms, there will be further resignations.

Detroit housing contract set aside on fraud charges

Contract for the $8,000,000 Herman Gardens housing project in Detroit was set aside Mar. 21 by circuit judge Harry B. Kiedan because of alleged fraud in obtaining the contract last October. Judge Kiedan held there was evidence that the contractors, Lipman Construction Co., and A. Smith & Co., both of Chicago, bribed two Detroit councilmen, and that public interest would not be served by permitting the original contract to stand. The city stopped payment on an estimate check for $147,000 issued Mar. 15, action which the contractors termed "wholly unjustified, constituting breach of contract." George Edwards, director-secretary of the Detroit Housing Commission, and Charles B. McGrew, chief engineer, are to report to the council on recommendations for completion of the project.

The Herman Gardens job has been in trouble ever since the award of the contract, which was based on concrete construction. Maurice L. Bein, Chicago, low bidder on a structural steel alternate, sued the city after the award, charging the council had no legal authority to make the award, for the housing commission had recommended giving the job to Bein, but was over-ruled by the council.

A lawsuit filed in Chicago against the Lipman and Smith firms by a subcontractor charged graft in the award of the general contract. Bein was then indicted by a Detroit grand jury on a charge that he, too, had attempted to bribe a councilman. Following this charge, Wm. S. Lipman, vice president of the Lipman Construction Co., was indicted for perjury before the grand jury. Action on these indictments has been delayed by consideration of disposal of the original contract.

• • •

Federal rights expanded along navigable streams

(*Continued from p.* 29)

railroad sought compensation. The government asserted that parts of the embankment were located below the original high water level and that no damages should be paid on these portions. The district and appeals courts held that this argument was irrelevant because the embankment did not in any way interfere with navigation. The high court, reversing the lower bodies, held that the federal government has complete power over the bed of a navigable stream below ordinary high water mark and that "any structure is placed in the bed of a stream at the risk that it may be so injured or destroyed."

More water conservation projects to be started

Nine projects have been approved, at a total cost of $14,623,000, and studies are underway for 50 more

Although a few technical legislative difficulties still stand in the way, the U. S. Bureau of Reclamation expects to get started this spring on five more of the Great Plains water conservation projects which it is carrying out jointly with the Department of Agriculture and the WPA. These are partially reimbursible projects authorized by the Wheeler-Case Acts of 1939 and 1940. Funds appropriated under the acts—a total of $8,500,000 so far—are reimbursible in much the usual manner of reclamation expenditures, but these funds are supplemented by non-reimbursible contributions of labor and some materials by WPA and CCC. This arrangement permits undertaking of projects which would not be economic on the usual reclamation formula. Reimbursible dam and reservoir costs of such projects are limited to $1,000,000. Nine such projects have been approved, with a total cost of $14,623,000, of which $6,268,000 is reimbursible.

Although money has been available for these projects for about two years, little progress had hitherto been made, due partly to legislative tangles and partly to the difficulty of arranging cooperation between the U. S. Bureau of Reclamation, which is responsible for the irrigation features, and the Department of Agriculture, which puts the land into shape and arranges for its proper use.

Three projects were started last year—Buffalo Rapids No. 1 and 2 in Montana, costing $560,000 and $1,840,000, respectively, and Buford-Trenton in North Dakota costing $1,500,000. The $2,560,000 Mirage Flats development in Nebraska was started early this year.

This spring five more similar projects will get under way: Eden, Wyo., $2,445,000; Bismarck, N. D., $590,000; Newton, Utah, $618,000; Mancos, Colo., $1,600,000; Rapid Valley, S. D., $2,910,000 (changes in plan may lower this figure). The Rapid Valley project includes a 157-ft. earth and rock fill dam with 1,100-ft. crest length to store 14,000 acre ft. of water, which will provide a supply for the town of Rapid City and a supplemented irrigation supply for 12,000 acres of land.

Early approval of the $1,050,000 Saco Divide project in Montana is expected.

Studies are now under way for about 50 proposed projects in 13 states. These projects are located by states as follows: Arizona 2, Colorado 6, Idaho 9, Montana 4 (including 16 pumping projects), Nebraska 2, Nevada 1, North Dakota 4, Oklahoma 2, Oregon 5, South Dakota 1, Texas 1, Utah 5, and Wyoming 7.

New Kentucky bridge will be 240 ft. above stream

Sometime in July bids will be opened by the Kentucky State Highway Department for a new deck truss highway bridge across the Kentucky River at Clay's Ferry on U. S. Highway 25, whose 26-ft. reinforced-concrete roadway (flanked by 3-ft. sidewalks) will be 240 ft. above low water. It will thus be the highest bridge in the state of Kentucky, and is further notable for containing the state's longest continuous truss, a three-span unit of 320-448-320 ft. At each end of the three-span section will be a 192-ft. truss span and two 50-ft. reinforced-concrete spans, making the overall length with approches nearly 1,700 ft.

Piers will consist of two concrete columns tied together with a structural web. All are founded on rock and the tallest will rise to a height of 205 ft.

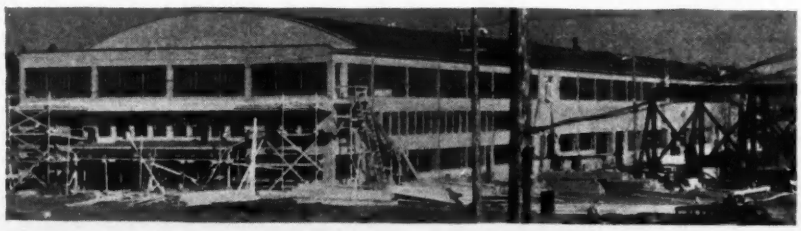
The bridge department of the Kentucky highway department, H. R. Creal, bridge engineer, is in charge of design.

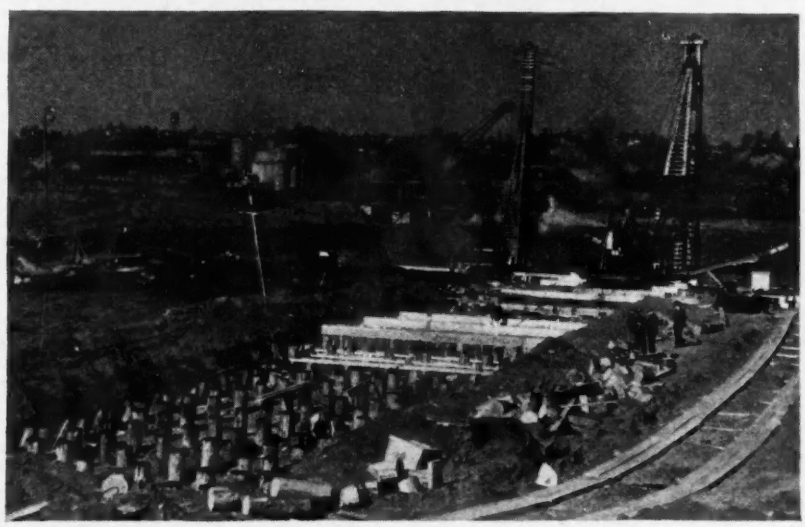
Miami sells bonds to buy and expand water system

Miami's $7,633,000 issue of water revenue bonds, to put the city in the retail water business, has been sold at a premium to bear an average interest rate of 2.78 percent for the 30-year life of the bonds.

Money produced by sale of the bonds will be used to buy and expand the city's water distribution system, now owned by the Miami Water Co., a Florida Power and Light subsidiary. Mayor Alexander Orr, Jr., announces the purchase of the water company's physical property for $4,500,000.

Sale of the $7,633,000 in water revenue bonds climaxed a move started two years ago to settle the city's long-standing controversy with the Florida Power and Light Co. and give the city complete control of the water system. Heretofore, Miami had produced the water supply at its wells in Hialeah, delivering it to the private company's network for distribution to consumers.





Shipyard construction for Navy minelayers at Portland

Willamette Iron & Steel Co. are building at Portland, Ore., a $1,542,000 shipway and yard project for the construction of minelayers for the U. S. Navy.

Included in the project is a two story administration building, recently completed, a mold loft building (as shown under construction in the upper picture above) erected on wood piling, two ship ways and a 600-foot outfitting dock. The lower illustration shows present progress of construction on one of the ways. Guy F. Atkinson Co. contractor.

Alabama road maintenance receives high PBA rating

Director Chris Sherlock, of Alabama's highway department, has received high commendation from PBA inspectors for the fine maintenance job being done on federal aid roads throughout the state. Ratings given the highway department range up to 97 percent of a possible 100, which averages 4 percent higher than ever achieved by previous road administrations in Alabama.

A rating of 100 percent was reported on a number of federal aid bridge projects. Marvin Taylor is maintenance engineer for the Alabama State Highway Department.

• • •

San Diego faces new sewage difficulties

Because of the growing defense program, San Diego faces sanitary conditions that were not expected to develop until 1960, states Dr. Bertram P. Brown, California state health director, who announces that a survey will be conducted immediately in an effort to find a solution to the problem.

In collaboration with Dr. Alex Lesem, San Diego county health officer, the survey will be made by the state department of public health and the U. S. Public Health Service.

The immediate problem involves the completion of the bay sewer. "A prompt, satisfactory solution is essential to protect the public health of the city's greatly increased population and to speed defense activities in the area," is the opinion of Dr. Brown.

• • •

Denison Dam fight carried to Supreme court

Governor Leon C. Phillips of Oklahoma, nemesis of the federal government's power-flood control projects in that state, has carried to the Supreme Court his legal fight to block construction of the $54,000,000 Denison Dam on the Red River between Oklahoma and Texas.

The high court has been asked to review a three-judge district court decision, handed down on Feb. 8, which denied a request for an injunction barring further work on the project.

The governor has contended that building the dam across Red River at the Oklahoma-Texas boundary was an invasion of the sovereign rights of the state. The dam is being constructed by army engineers.

JOBS OF THE WEEK

TUNNELS, Pulga, Calif.

Pacific Gas & Electric Co., San Francisco, Calif., has awarded contract for the construction of Cresta and Pulga pressure tunnels and surge chambers and appurtenances on north Fork of Feather River, to T. E. Connolly, San Francisco, Calif. Estimated cost will be about $6,000,000.

AIRPLANE PARTS PLANT, Fort Wayne, Ind.

Consolidated Construction Co., Chicago, Ill., has been awarded contract for superstructure for four 1-story buildings, including power house, and heat treating buildings by War Department, Washington, D. C., and Studebaker Corp., South Bend, Ind., who will operate plant. Estimated cost $930,000. Total estimated cost with equipment, $5,000,000. Giffels & Vallet, Inc., Detroit, Mich., are engineers.

HANGARS, Washington, D. C.

John McShain, Inc., Philadelphia, Pa., was lowest bidder for the construction of five hangars at Washington National Airport, Gravelly Point, Va. Public Buildings Administration, Washington, took bids and the low offer was $2,028,200.

HOUSING, Manitowoc, Wis.

J. P. Cullen & Son, Janesville, Wis., and S. M. Siesel Co., Milwaukee, Wis., have been awarded contracts for constructing 400 housing units by Manitowoc Housing Authority, Manitowoc. Estimated cost is $1,500,000.

SEWAGE TREATMENT WORKS, Jamaica, N. Y.

Caye Construction Co., Brooklyn, N. Y., has been awarded contract for buildings and equipment for Jamaica Sewage Treatment Works, by Department Public Works, New York, at $1,245,563

AIR BASE FACILITIES, Meridian, Miss.

Alfred B. Friend, Volz Construction Co., The Rock City Construction Co. and Flint-Jordan Construction Co., all of Jackson, Miss., have been awarded contract by the War Department, for the construction of air base facilities, at Meridian Airport. Burge & Stevens, Atlanta, Ga., also received a collateral contract for architectural and engineering services. The total estimated cost is $1,408,535.

HOUSING, Brooklyn, N. Y.

Corbetta Construction Co., New York, N. Y., has been awarded contract for foundations and appurtenances for 3,501 apartments, Fort Greene Housing Project, by New York City Housing Authority, New York. Job was awarded on low bid of $1,089,000. William F. Ballard, New York, consulting architect.

Architects on unit 1 Harrison & Fouilhoux, chief architects. Rosario Candela and Albert Mayer, associated architects.

On Unit 2. Ely Jacques Kahn, New York, chief architect. William I. Hohauser, Inc., Ethan Allen Dennison, all New York, associate architects.

Unit 3. Clarence S. Stein, chief architect. Charles Butler, Robert D. Kohn and Henry S. Churchill, New York, associate architects.

STEEL PLANT, Manchester, Tex.

Southwestern Construction Co., Houston, Tex., has been awarded contract to construct steel mill for manufacturing billets for shell forgings, and light steel plates for ship building. Estimated cost is $12,560,000. Sheffield Steel Corp. of Texas, c/o American Rolling Mill Co., Middletown, O., is owner. Kenneth Franzheim, engineer, c/o contractors.

HOUSING, St. Louis, Mo.

I. E. Millstone Construction Co., St. Louis, Mo., was the lowest bidder for 657 unit community housing project, Clinton Terrace Project No 1-2, by St. Louis Housing Authority, at $1,717,000. Estimated total cost is $2,167,000. Mauran, Russell, Crowell & Mullgardt and B. M. Corrubia, associated architects.

BREAKWATER, Los Angeles, Calif.

Columbia Construction Co., Oakland, Calif., has been awarded contract for constructing 13,350 lin. ft. composite type detached breakwater and restoring existing 12,500 ft. detached breakwater in Los Angeles and Long Beach Harbors, at $10,321,300. U. S. Engineers, Los Angeles, took bids March 25.

WAREHOUSES, Atlanta, Ga.

Construction Quartermaster, Atlanta, General Depot, has awarded contract for warehouses and utilities to A. Farnell Blair, Decatur, Ga., $4,271,984.

DRYDOCKS, Brooklyn, N. Y.

Walsh Construction Co., J. Rich Steers, Inc., Caldwell-Wingate Co. and Raisler Corp., New York, will build shipbuilding drydocks, at New York Navy Yard, for Bureau of Yards and Docks, Navy Department. Estimated cost $31,000,000.

NOTE—Additional bidding and contract news on over 800 projects large and small appear in the Construction News section beginning on page 123.

OBITUARY

LELAND H. KIMBALL, 55, engineer for the metropolitan water district of Salt Lake City, Utah, was accidentally killed Apr. 1 at Grantsville, Utah.

JOSEPH MAYO METCALF, assistant chief engineer, Missouri-Kansas-Texas Railroad for the past 20 years, died Mar. 23 at St. Louis, Mo.

ROYAL E. PETTY, 49, civil engineer, with the Wheeling & Lake Erie Railroad, died recently at Cleveland, Ohio.

PETER E. SPARRE, chief engineer for Hutchinson & Co., Great Lakes ship operators, died recently at Burbank, Calif.

LEROY N. JONES, 43, civil engineer, Atlantic City, N. J., water department, died Mar. 22, at Philadelphia, Pa.

LIEUT. GRANT MOLONEY, 36, editor of the Canadian Engineer publications, of Toronto, was recently killed in England serving with the Canadian armed forces.

M. V. CURRAN, engineer of Koochiching county, Minn., 51, died recently at International Falls, Minn.

CHARLES M. BRIGHT, 56, construction engineer, Council Bluffs, Iowa, was killed in a highway accident recently.

NORMAN M. REXFORD, 51, Minnesota highway department engineer, died recently at Minneapolis.

ROBERT BARFIELD HAWKINS, foreman for Utah Construction Co., was accidentally killed recently at Nantahala Dam, North Carolina.

P. H. BYWATER, 58, engineering construction superintendent, A. Guthrie & Co., died recently at St. Paul, Minn.

JOHN MONIGHAN, pioneer in the development of the walking dragline excavator and founder of the Bucyrus-Monighan Co., died Mar. 24 at Chicago.

EDWIN J. HOLLAND, 59, prominent building contractor of Atlantic City, N. J., died Mar. 25.

CONTRACTS AND CAPITAL

ENGINEERING CONSTRUCTION awards for the week, $139,176,000, are 174 percent higher than in the corresponding 1940 week, and rise sharply from the 1941 low of last week, gaining 102 percent. Increased volumes of public and private construction are responsible for the gain. Public construction is 259 and 110 percent higher, respectively, than a year ago and a week ago, and private awards are up 72 percent over last year, and 82 percent over last week.

The current week's construction brings the 1941 total to $1,669,413,000, a 123 percent gain over the volume for the opening 15-week period last year. Private awards are 73 percent higher, and public is up 150 percent as a result of the 898 percent rise in federal work.

In the classified construction groups, gains over the 1940 week are in waterworks, sewerage, bridges, industrial and public buildings, earthwork and drainage, and unclassified construction. All classes of work except waterworks, commercial buildings, and streets and roads are above their last week's volumes.

New capital for construction purposes for the week totals $111,549,000. This compares with $10,302,000 for the 1940 week. The current new financing total is made up of $98,882,000 in federal funds from the Deficiency Appropriation Bill, $10,300,000 in corporate security issues, $2,337,000 in state and municipal bonds, and $30,000 in RFC loans for public improvements.

New construction financing for the year to date, $2,280,741,000, is 585 percent above the total for the 15-week period last year.

CONTRACTS

(Thousands of dollars)

	Week Ending Apr. 11 1940	Apr. 3 1941	Apr. 10 1941
Federal	$5,768	$21,608	$71,237
State & Municipal	21,746	25,291	27,588
Total public	$27,514	$46,899	$98,825
Total private	23,376	22,090	40,351
TOTALS	$50,890	$68,989	$139,176
Cumulative 1941 (15 weeks)			$1,669,413
1940 (15 weeks)			749,468

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1940 15 weeks	1941 15 weeks
NON-FEDERAL	$333,421	$313,856
Corp. Securities	45,709	101,243
State & Mun	213,420	173,049
U.S.H.A. loans	73,551	13,521
R.F.C. loans	741	26,043
FEDERAL		$1,966,885
TOTAL CAPITAL	$333,421	$2,280,741

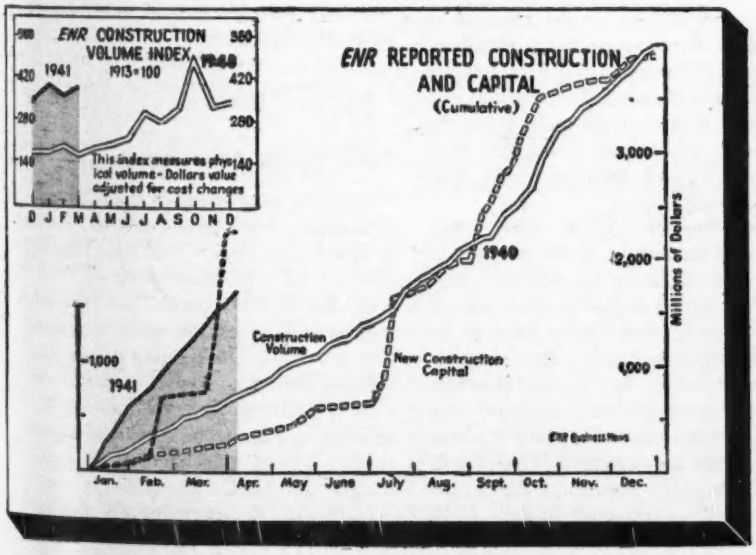
FHA MORTGAGES

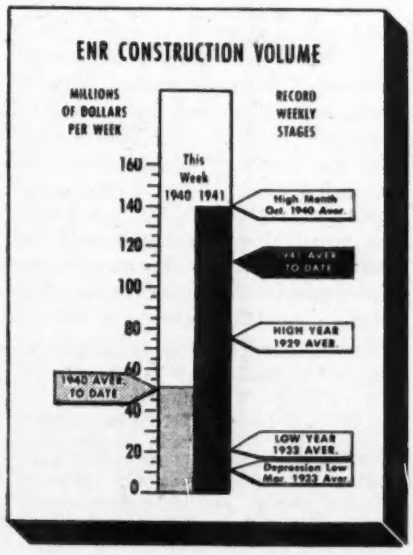
	Week Ending Apr. 6 1940	Mar. 29 1941	Apr. 5 1941
Selected for appraisal	$27,731	$34,281	$35,045*
Cumulative 1941 (14 weeks)			$347,997*
1940 (14 weeks)			$297,569*

* Subject to revision.

ENR INDEX NUMBERS

Index Base=100		1913	1926
Construction Cost	Apr. '41	252.40	121.33
Building Cost	Apr. '41	208.60	112.76
Volume	Mar. '41	386	169





Comment and Discussion

Readers' opinions on matters that concern engineers and contractors

Uniformly Tapped Pipes

Sir: May I add the following discussion concerning R. D. Gladding's article on loss of head determination in uniformly tapped pipes (*ENR*, Nov. 21, 1940, p. 697).

The writer became interested in the problem of flow from manifold openings or ports and carried out experiments relating to it in the hydraulics laboratory of the University of Illinois in 1932-33. The solution of the problem, either analytically or experimentally, is difficult. There are four very important variables for each manifold opening: the head on the opening, the velocity of the fluid in the pipe, the diameter of the pipe, and the diameter of the opening. As mentioned in other discussions (*ENR*, Jan. 16, 1941, p. 78), Mr. Gladding's assumption that discharge is the same from all manifold openings changes the problem greatly and could only be obtained by using individual flow characteristics for each manifold opening, such as variable diameters.

The writer's experiments were conducted on a horizontal brass pipe 3 in. in diameter and 10 ft. in length. The brass pipe was preceded by about 26½ ft. of straight steel pipe and was followed by about 5 ft. of steel pipe. Two manifold openings were drilled in the brass pipe 2 ft. apart. The head on these openings was measured by open manometers 6 ft. high. Discharge from the pipe was controlled by a valve downstream from the test section. The average velocity in the pipe preceding the manifold openings was varied from less than 0.5 to greater than 16 fps. Tests were made on ¼-in., ⅜-in., ½-in., and ¾-in.-dia. manifold openings. Although it was thought that the tests made were inadequate for final conclusions, the results indicated that:

(1) The coefficient of discharge of each manifold opening depends on the relative values of head on the manifold opening and the velocity in the pipe. As an example of this, when the velocity in the pipe preceding the manifold openings was kept constant and the head on the upstream manifold opening was varied from about 0.5 ft. to 6.0 ft., the coefficient of discharge varied from approximately 0.50 to 0.61.

(2) Any empirical equation, derived from experimental data, for co-efficients of discharge of manifold openings should be used only under conditions nearly like those used in determining the co-efficients. Curves obtained from such equations should be extrapolated very cautiously.

During the present year, 1940-41, a more elaborate apparatus has been constructed and an effort will be made to obtain a more thorough and complete experimental and analytical solution than has yet been published.

W. M. LANSFORD
Assistant Professor of Theoretical and Applied Mechanics
University of Illinois
Urbana, Ill.

Sir: Juxtaposition of the two letters by F. W. Edwards and Frederick C. Ziegler in your issue of Jan. 16 (p. 78), created an amusing situation. Both letters criticized the article "Loss-of-Head Determinations in Uniformly Tapped Pipes," by R. D. Gladding. Mr. Gladding evidently had meant by "uniformly tapped" that the outlets were adjusted so that they each discharged the same quantity. Mr. Edwards assumes that it meant that the outlets are all exactly alike and says that they would not discharge equal quantities because the velocity in the main pipe decreases as it approaches the dead end, and therefore both the pressure and the discharge per nozzle will increase as the dead end is approached. Mr. Ziegler raised the same objection but for the opposite reason. He says that due to friction loss in the main pipe, the pressure, and therefore the discharge per nozzle, will decrease as the dead end is approached.

As a matter of fact, the friction loss is ordinarily more important than the recovery of velocity head and in the example worked out by Mr. Zeigler, very little error is introduced by neglecting the change in velocity head. But if the taps are spaced much closer together along the pipe, the recovery of velocity head should not be neglected. The following table gives the results for a 4-in. pipe with a Hazen-Williams C of 100, with the taps spaced 5 ft. apart and discharging $20\sqrt{h_p}$ gpm., where h_p is the pressure head in feet. The No. 1 tap is at the dead end, and the computation is carried upstream by use of Bernoulli's theorem.

Nozzle No.	Pressure Head ft.	Nozzle Discharge gpm.	Total Pipe Flow gpm.
1	1.000	20.0	20.0
2	0.991	19.9	39.9
3	0.983	19.8	59.7
4	0.979	19.8	79.5
5	0.984	19.8	99.3
6	1.000	20.0	119.3
7	1.034	20.3	139.6
8	1.085	20.8	160.4
9	1.158	21.5	181.9
10	1.257	22.4	204.3
11	1.486		

As far as tap No. 4, Mr. Edwards' thesis is maintained, and the pressure decreases upstream. But from there on it increases until at No. 6 it is the same as at No. 1, and at No. 10 it is 26 percent higher. If this problem were worked by Mr. Ziegler's (and Mr. Gladding's) method of considering only friction losses, the pressure head would be 14 percent higher at No. 6 than at No. 1, and 72 percent higher at No. 10 than at No. 1.

The total friction loss in 50 ft. of this pipe adds up to 0.894 ft., which is quite near the 0.926 ft. given by Mr. Gladding's method, so that the inequality of the flow in the various nozzles does not involve any large error here. But the neglect of the velocity head recovered is much more serious. In this case the drop in the hydraulic gradient in the 50 ft. is only 0.486 ft. The computations are based on velocity head $= \frac{v^2}{2g}$. If it had been taken as $1.04\frac{v^2}{2g}$, which would be more nearly the case, the error due to neglecting it would have been still larger.

RALPH W. POWELL
Associate Professor of Mechanics
Ohio State University, Columbus, Ohio

Limit Design Economy

Sir: As pointed out in the editorial comment preceding the article "How to Use Limit Design" (*ENR*, Jan. 2, 1941, p. 41), the publishing of Prof. Van den Broek's paper has focused considerable attention upon this theory of design. The ensuing discussion divides itself into two considerations which, although interrelated one to another, are apt to be examined separately before the theory becomes widely accepted. The first is concerned with the logic of the theory and has much to recommend itself to

engineers familiar with the behavior of mild steel when strained locally beyond the yield point by self-limiting stresses. The second is concerned with the economies resulting from the use of the theory.

In the example cited in Mr. Peterson's article the capacity loading permitted by limit design is 2,312 lb., live, plus 400 lb. dead load or a total of 2,712 lb. per lin. ft. For the ordinary design method the corresponding loadings given are 1,384 + 400 = 1,784 lb. per lin. ft. The increase in allowable loading by the use of limit design, would be

$$\frac{100\ (2{,}712 - 1{,}784)}{1{,}784} = 52.0 \text{ percent}$$

which suggests a substantial saving when designing for a specified loading.

There is an error in the determination of capacity loading by the ordinary method. The moment of inertia of the 4-in. 9.5-lb. I-beam should have been 6.7 instead of 6.0. The corrected values, by increasing the capacity loading for the ordinary design solution, reduces the comparison from 52 to 36.1 percent.

Further modifications are justified in developing the comparison, on the basis of modern practice in the use of the usual design theory and structural steel conforming to A.S.T.M. specifications A7-39. In recognition of the minimum values prescribed by this specification for the physical properties of the steel, the American Institute of Steel Construction recommends an allowable bending stress of 20,000 lb. per sq. in. This limit has been widely adopted in building codes all over the country and is generally accepted by engineers in connection with designs by the ordinary theory. Its use here would seem, therefore, more fitting in evaluating the load capacity determined by this theory. This would permit a live load of 1920 lb. per lin. ft. in the example cited.

Since the A.S.T.M. specification permits a minimum yield point of 33,000 lb. per sq. in., this value should be used instead of 36,000 if a safety factor of 2 is to be claimed for the limit design loading. This modification would reduce the capacity live load for the limit design to 2,088 lb. per lin. ft. The revised comparison would then be

$$\frac{100\ (2{,}488 - 2{,}320)}{2{,}320} = 7.2 \text{ percent}$$

which is quite different from the 52 percent cited.

While calling attention to the desirability of the suggested modification in comparisons of results obtained by the two theories, the writer recognizes that studies on spans of different proportions and conditions of end fixity can still show marked economies for the limit design method, and the economic consideration will continue to be a factor in discussing the theory's merit.

T. R. HIGGINS
American Institute of Steel Construction
New York, N. Y.

Camp Edwards Sewage Plant

Sir: In your article on "Sewage Treatment for Army Camps" (*ENR*, Mar. 27, 1941, p. 479), the data tabulated for the disposal plant at Camp Edwards is in error. It so happens that the basic design data for the Camp Edwards plant were prepared and construction was under way before the consulting engineers mentioned in your article made their report to the War Department. The average sewage flow is estimated at 3 mgd. instead of 2.1 mgd., and single-stage biofilters were used instead of two-stage as shown in Table II.

The plant consists of a comminutor, a diffused air grease separator, Imhoff tanks, two trickling filters, final settling tanks and 12 acres of intermittent sand filters. There is no river or other body of water in the vicinity of Camp Edwards so that all the sewage must go into the ground.

I happen to have before me the flow record for March 21; on this day the population of the camp was 22,600 and the volume of sewage amounted to 2.1 mgd. in 24 hours. Maximum rate of flow was 3.4 mgd. at 8 a.m.

SAMUEL M. ELLSWORTH
Consulting Engineer
Boston, Mass.

Bearing Wall Buildings Approved

Sir: Our experience does not bear out the conclusion of your editorial of Feb. 27, "Bearing Walls Indicted". We believe the two-span wall-bearing slab as used on federal-aid housing affords economy of construction that is well-nigh revolutionary. We have under way, or have recently completed, at Utica, N. Y., and Bridgeport, New Haven and Hartford, Conn., some 14 miles of such slab, about 27 ft. wide, involving, with foundations, 60,000 yd. of concrete. Eighty percent of this work is wall-bearing. Buildings run two, three and four stories high.

We have found no particular difficulty in coordinating the concrete work with the brickwork. One top story at New Haven was completed in three days, brick and all. On account of the elaboration of form work and reinforcement, we doubt that an independent concrete frame can be erected any faster; we, at least, have not done it.

Based on our contract prices, with due consideration for variations in individual projects, we believe the concrete frame costs at least fifteen percent more per square foot than the wall-bearing construction. There seems to be no corresponding saving in brickwork cost. So far as we know, there has been no cracking of exterior walls on any of these buildings.

We have also prepared detailed estimates on the concrete superstructures for the six-story Queensbridge Housing and Vladeck Housing jobs, both in New York City. Queensbridge is slightly more complicated; but, in spite of this, our square foot cost on Queensbridge is eighteen percent lower than on Vladeck. In buildings of this height, the framed structure shows some saving on brickwork cost. We are not aware of any cracking at Queensbridge.

HENRY WILLCOX
President, Willcox Construction Co., Inc.
Long Island City, N. Y.

Re "Firm Power"

Sir: Your Feb. 27, 1941, issue contained a very interesting article entitled "TVA Rushes Power for National Defense." I believe the first sentence of the summary paragraph, although technically correct, should be clarified as it is apt to be misleading. The statement that the new construction will add 300,000 kw. of firm power refers to 300,000 kw. of additional rated capacity. Frequently the term "firm power" is used to mean "*continuous* firm power." The continuous or firm power added by the emergency construction program will be in the neighborhood of 220,000 kw. whereas the rated capacity will be approximately 300,000 kw. This is a small point, but I am taking this opportunity to clarify the statement to avoid any misinterpretation.

T. B. PARKER
Chief Engineer
Tennessee Valley Authority

EDITORIALS

VOLUME 126 NUMBER 15

April 10, 1941

Superhighway Planning

ESTIMATES of the cost of building a toll road from Boston to Washington—$253,000,000 for 405 miles—serve to show how costs of building superhighways through congested areas continue to mount, and point to the necessity for early and generous planning for better highways between the large centers of population. Whether such roads shall be toll or free is not important to this planning. A superhighway connecting the main centers of population along the North Atlantic Seaboard is badly needed and, since such a road must be a "freeway," without intersections at grade, limited as to access, and without encroachment by roadside stands, its characteristics will vary little whether toll or free. That is the significance of the study reported in this issue. Crossing seven states, a superhighway from Boston to Washington cannot be of maximum usefulness without close cooperation during the initial stages in selection of a route. Some of the funds appropriated by Congress for surveys and plans for strategic highways could well be spent on plans for this superhighway.

Double Diversion

THE NEW YORK STATE LEGISLATURE has approved a constitutional amendment calling for the diversion of $60,000,000 from the money remaining in the state's $300,000,000 grade-crossing fund for use on parkways and highways. All the crossings have not been eliminated, but highway and parkway needs are more acute at present due to the diversion of part of the state's income from gas tax and motor vehicle fees to other than highway purposes. Hence the state's resort to double diversion, a diversion which in effect is the taking of bond proceeds to meet current state expenses having nothing to do with either highways or grade crossings. And to make matters worse the diverted millions will not begin to meet the state's accumulated highway needs because the New York highway department has been too long deprived of funds by gas tax and fee diversion. The $60,000,000 will help, of course, but if the legislature had the best interests of the state's highways at heart the constitutional amendment that would be most advantageous would be one prohibiting the diversion of motor taxes from highway use. Such an amendment would have made fund juggling unnecessary.

Service Charges for Refuse Disposal

SERVICE CHARGE FINANCING of public facilities probably is the sole hope of cities faced with increasing needs and decreasing tax revenues. The idea of payment on the basis of service rendered is not new, of course; most recently it has become widely accepted as a means of financing the construction of sewerage works. On p. 48 of this issue a good argument is presented for the application of service charges to refuse collection and disposal operations, one of the most neglected municipal functions largely because of insufficient funds to do a proper job. If cities hope to make improvements—and public agitation strongly demands that they do—then more must be hoped for than an appropriation from general tax funds. Precedent for the use of a fee or a service charge for refuse disposal may be found on the West Coast, but cities east of the Rockies have either avoided or ignored this method of financing such operations. Upon examination, it may be found that they are overlooking something worth while.

The Inspector's Job

INSPECTION of construction work is a difficult job, one that may pay the owner large returns if done well and yet one that owners or their engineers value so low as to make it unprofitable for any man to follow as a life work. Thus inspection falls largely to the lot of young men just out of school who lack practical experience and mature judgment. Elsewhere in this issue one of the engineers of the Panama Canal discusses some of the things that might be done to improve inspection practices on large operations where a staff of inspectors is employed. The clearer definition of functions and authority that is called for in that discussion will be equally advantageous on smaller operations; but no permanent solution will be found until engineers and architects learn how to write specifications that are not full of ambiguities, which have to be interpreted in the field, and until they put a value on inspection that will make it attractive for men to develop special ability in that field. Reputable contractors do not knowingly skimp on a job, but their bids have to include a margin to cover unforeseen interpretations of ambiguous words in specifications. Skilled inspectors who could weigh

such wording with justice tempered with common sense would make such hidden costs unnecessary.

From Highways to Airports

FROM ITS ORIGINAL USE as a material for improving the load-bearing properties of highway bases, the soil-and-cement mixture has recently been extended to airport runways. This adaptation has been accompanied by corresponding refinements in design and processing, as indicated in the article reviewing work at the Army's Westover Field. On this project the thoroughness of mixing and the care of moisture control resulted in a product equaling the weight of concrete. As a new aid in processing, the engineers borrowed an agricultural implement in the form of a rotary tiller, which aided in mixing to a uniform depth. The design innovation was the use of added cement in the top of the mix, just prior to final compaction, to improve strength and wear resistance of the surface. As service record data are added to this expanding information on placing procedure, soil-cement will strengthen its position as an important engineering material available for the airport builder's use.

Congressional Sabotage

THERE MAY BE A NET GAIN to the national defense construction program in the new policy of the Quartermaster Corps that prohibits hiring engineers as consultants whose firms hold QM construction contracts, but only clairvoyance can reveal it. Beyond saving General Somervell's time in unnecessary appearances before a busybody Congressional committee to prove that he and his consultants are neither thieves nor crooks, any possible gain escapes us. Only engineers have so far been affected but logic compels that the policy cover contractor consultants too.

The net result of the new policy, which stems from the fact that a few members of Congress can't imagine how a man can hold an office of public trust without using it to his own and his friends' advantage, is to deprive the country of topnotch ability when it needs it most. If such men as Samuel Greeley, E. B. Black and Enoch Needles, to name only three who have had to resign, cannot be trusted, the country is in a bad way. To replace the consultants now on the staff with men having equally broad experience is going to be difficult. To expect them to renounce contracts for their firms, as the price of staying on, is fair neither to the other members and employees of the firms nor to the country, which needs these firms on national defense work. To demand that the consultants resign from the firms is unrealistic; as well ask them to resign from their families.

Putting obstacles in the way of utilizing all the talent that we have at the present time is, to be charitable in characterization, shortsighted. Congress, through coercion of the construction division of the Quartermaster Corps, has committed a neat act of sabotage.

Unions and Fees

BLACK MARKS against the reputation of either an individual or an organization are hard to erase. The AFL Building Trades Council is experiencing the truth of this statement in its current attempts to make amends for its completely indefensible practice of charging non-union workmen fees to work alongside union men. Latest move is a promise to do away with such fees on future work, but the black mark is still there until the promise is implemented by widespread action.

Furthermore any action taken will have to be unequivocal. Charging a fee and giving only temporary membership in the union in return is no reform. Likewise keeping so-called legitimate fees at present high levels will hardly be construed as evidence of good faith. As a matter of fact, requiring a man to join a union at all as the price of getting a job is decidedly open to question as to its legality.

Contractors and government officers who became a party to the form of blackmail represented by fee collection, in the belief that it was an inevitable part of the drive to speed the defense program—which would be eliminated once it was brought to the attention of Congress—must be sadly disillusioned by the failure of Congress to act. Had they precipitated strikes by barring the high fees they might actually have advanced the national defense program.

The fee system was not a pretty picture no matter how you looked at it. If more honest conditions are going to prevail in the future, that is good news indeed.

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With far end enclosed, workers push construction on remainder of tank arsenal in bitter cold.

FACTORIES FOR DEFENSE

Chrysler Builds a Tank Arsenal

***Contents in Brief**—Few factories have been built with less precedent behind them or more push to get them into production than the government-owned tank arsenal that the Chrysler Corp. will operate in Detroit. Laying out bay widths and arrangements that would fit production lines was a pioneer undertaking. Designing and erecting a 500x1,380-ft. building in seven months, most of them cold and damp, was an outstanding accomplishment. What the building is and how it was built are outlined in this first of a series on* Factories for Defense.

As An Antidote for that feeling, mistaken though it generally is, that the defense effort is not proceeding according to schedule, there can be recommended a visit to any one of a dozen or more huge industrial plants that are being built to turn out munitions of various kinds. And among them none is more worthy of inspection than the Detroit Ordnance Works, better known as the Chrysler tank arsenal, which is one of the most important of the projects being carried out by the construction division of the Quartermaster Corps.

Given a government contract on Aug. 15, 1940, to build, for $5,000,000, and equip, for $15,000,000 more, a 690,000-sq.ft. tank factory, Chrysler Corp. in only seven months has, in spite of severe weather conditions, finished the building and is already installing machinery. When all the machinery is received and installed, plans call for the production of five 25-ton tanks a day. Behind this achievement is an organization of Chrysler engineers, Quartermaster and Ordnance officers, consultants, contractors and workers who cooperated without cavil and worked far beyond both the effort and hours that even a strict accounting to duty called for.

The means by which these results were accomplished and the structure that expresses them in steel, concrete, brick and glass, are well worth description.

Building plan and structure

First the structure. Located on a 113-acre patch of prairie some 4 miles north of the Detroit city limits, the plant is a one-story butterfly monitor roof structure, 1,380 ft. long east and west, and 500 ft. wide north and south. It is supplemented by a four-story 50 x 260-ft. reinforced concrete administration building, a one-story 50 x 160-ft. steel framed personnel building, a boiler house and a figure 8 test track on which the tanks will get a 75-mile run-in before shipment.

Probably 95 percent of factory wall surface is glazed with more than 80,000 individual panes. In this one respect at least it follows the trend of many a peacetime factory, but its roof truss spans, general head clearance and arrangement are of course characteristic only of a plant that would meet the requirements of battle tank manufacture. No existing automobile plant could have been used.

Running the 1,380-ft. length of the north side is a bay 60 ft. wide containing a depressed railway track and an unloading dock. This is the receiving aisle. At right angles to this are production aisles 60 ft. wide across the building through which fabricating parts will move to the 80-ft. assembly aisle that runs the length of the south side of the building.

Receiving, manufacturing and assembly areas thus are expressed by different framing layouts. In the 60-ft. receiving and 80-ft. assembly aisle, column supports are 20 ft. apart, vertical clearance to the roof truss bottom chords being 29 and 39 ft. respectively. In the manufacturing

area, bays are 60 x 45 ft. and clearance is 21 ft. The whole building is divided transversely into thirds by accordion-type expansion joints, continuous over roof and walls. The roof is of precast cement tile covered with built-up tar and gravel roofing. The floor is an 8-in. reinforced concrete slab covered with 150 carloads of creosoted wood block except for the areas occupied by about 150 machine foundations (the largest of which support 25-ton loads) that are spread on a clay soil with the high capacity of 6,000 lb. per sq.ft.

What makes it tick

To these elements which inclose and support the machines must be added the utilities that make the plant function. To as great a degree as possible main supply lines are kept outside the building. Thus the 10-in. cast-iron sprinkler piping from a 150,000-gal. elevated tank entirely encircles the building, only the 8-in. branches at about 100-ft. intervals running inside under the floor to risers at the first interior row of columns. The 48-in.-dia. concrete storm sewer, which takes all of the roof drainage, is outside the north wall; laterals 60 ft. apart under the floor slab bring the roof drainage to it, and at its far end it picks up the effluent line from the sewage treatment plant. Finally the main electric conduit from the powerhouse is also outside the north wall of the building; branches lead up to three substations on the roof from where distribution is down to an underfloor system connecting with main supply panels on the columns. The lines that lead from these panels to the various machines are on top of the floor slab but under the wood block, where they are easily accessible for changes.

Except for the power ducts the only underfloor utilities are twenty-some storm sewer laterals and two cross-connected sanitary sewers that run lengthwise of the building. The one on the south side extends beyond the end wall of the building to discharge into the sewage treatment plant, a simple lime-settling basin.

Medium pressure steam for the unit heaters is carried in pipes on the roof trusses, as are compressed air, oil for machining work, propane gas for cutting operations, and hot and cold water for the locker and toilet rooms. This domestic water will be supplied by a new 4-mile-long cast-iron main connecting to the Detroit city system, while sprinkler and cooling water will come from wells on the property.

Artificial lighting is not intense, since only a daytime shift is contemplated initially; in general, fixtures are on 20-ft. centers at bottom chord level and contain one 400-watt mercury lamp and three 150-watt mazda lamps. Two 40-ton overhead cranes in the assembly aisles of the manufacturing and storage area will move the heavy tank parts and service the machines.

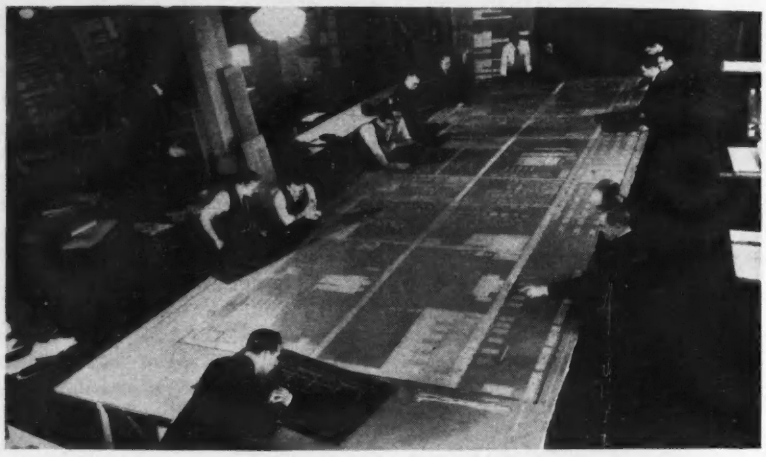
Planning under pressure

How and with what this factory designing and building job was kept to a schedule drawn up without benefit of precedent and influenced by a desire to accomplish the impossible in getting tank production started is the next part of this story. E. J. Hunt, former Chrysler Corp. master mechanic, who has been appointed operating manager of the arsenal, Col. H. W. Rehm, commanding officer of the arsenal for the army and Maj. H. R. Kadlec, constructing quartermaster agree that the most potent factor was *esprit de corps*. Since this is something that can neither be described nor illustrated it is necessary to turn to the procedures that implemented this spirit.

A brief review of the schedule would start a month before the contract was signed when William S. Knudsen of the OPM asked K. T. Keller, president of Chrysler, if he would build tanks. Mr. Keller said he would. Followed a trip to Rock Island Arsenal to see the tanks and get the drawings, and a return to Detroit where 197 Chrysler men began putting in 70 hr. a week for 4½ weeks to develop processes, estimates and machines on paper, to plot them in a production line and to develop general dimensions of a building. The contract was signed Aug. 15, 1940, and preparation of architectural, structural and mechanical plans was turned over to the Albert Kahn organization. Sept. 11 first ground was broken. Sept. 18 contract for steel fabrication and erection was let to Bethlehem Steel Co. Oct. 1 the general contract was let to O. W. Burke Co., Detroit, who completed the first footing that day. Nov. 19 steel erection began. First roof tiles were laid Dec. 9, followed by roofing on Dec. 13. Steel sash on monitors began Dec. 11, on walls Dec. 13, and glazing followed on Dec. 18. Thus all enclosure elements were under way, and a month later, on Jan. 28, steel erection (6,500 tons) was complete. By this time machinery was being moved into the third of the building at one end that was complete, and on Feb. 10 supervisory forces reported to begin work on a pilot tank. From then on until April

A crane girder is lifted into place. Snow and cold, bad as they were, were preferred to warm days when the site was a quagmire.

***The bosses confer on the job.** Left to right, Major H. R. Kadlec, constructing quartermaster, E. J. Hunt, operating manager of the plant for Chrysler and H. L. Weckler, vice president and general manager of Chrysler Corp.*



***How it all began.** Chrysler Corp. engineers developing the building layout by spotting machines and production lines for turning out five 25-ton tanks a day.*

1, completion date for the building, construction continued on schedule, but the fever heat of effort was transferred to machinery installation and production practice.

Putting the pieces together

The construction practices that made this recital of dates possible were not unusual although they were of a type that insured speed. Stripping the site of about 12 in. of soft material was attacked by tractors and carrying scrapers which made short work of this initial job. All operations moved from east to west and, as soon as the first hundred feet or so was stripped, power shovels moved in to dig the 448 individual footings while pullshovels attacked the 3,760 ft. of trench for the continuous wall footings. Average excavated depth was only 4 ft. Foundations were formed and concreted within a day after they were excavated.

Right behind footing work came excavation of underfloor trenches, also with pullshovels. Storm sewer trenches, on 60-ft. centers across the building, went down as much as 8 ft. The two longitudinal and two-cross connection trenches for the sanitary sewer system were somewhat shallower while the power conduit trenches were even nearer the surface. By the time first steel arrived on Nov. 19, utility line excavation and laying was far enough advanced to stay ahead of steel erection, which began on that day.

One piece of foresight, which contributed greatly to progress, was the early construction of the permanent 30-ft.-wide concrete roadway that runs the length of the plant on the north side. Had it not been for this roadway, supply trucks and equipment could not have got beyond the plant gate on the many warm days in December when the ground thawed into a morass.

Steel erection coincided with the period of worst weather. Fortunately the contractor elected to lay two temporary railway tracks the length of the building, one in the 80-ft. bay and one on the building centerline, and bring his carloads of steel in over them; trucking it in would have been impossible. While two locomotive cranes unloaded steel, a truck crane and four crawler cranes began setting it. All trusses came to the job in one piece, so field assembly was not a problem. As soon as the locomotive cranes completed their unloading jobs, they too were put on erection.

Principal difficulty arose from the desire to finish the first third of the building (shut off from the remainder by a temporary plywood wall) so that machines could be moved in and production preliminaries started. And the specific difficulty was the frozen ground upon which the floor slab could not be placed. The unit heaters had been installed early but there was no possibility of any more speed-up on the power plant boiler installation. The solution was to run a railroad locomotive into the building and connect it to the heaters for a temporary steam supply. Heat so supplied kept the inside temperature above freezing, while localized heat was progressively applied to areas of about 16,000 sq.ft. by about 150 salamanders under a tent enclosure. With thawing complete, the soft muck was stripped off by carrying scrapers, a backfill of sand placed and the slab poured. Heat from the locomotive then prevented subsequent freezing.

For the remaining two-thirds of the building steam from the boiler plant was available in sufficient quantity to permit the permanent unit heaters to do all of the thawing, eliminating the use of both the locomotive and the salamanders.

The building was planned by the Chrysler Corp. staff and designed by Albert Kahn Associated Architects & Engineers.

Lowering falsework bracing bent through whose hollow legs H-piles were driven to rock.

H-Piles in Hollow-Leg Bents For Bridge Falsework

Frank Peirce

Resident Engineer, Phoenix Bridge Co.
Phoenixville, Pa.

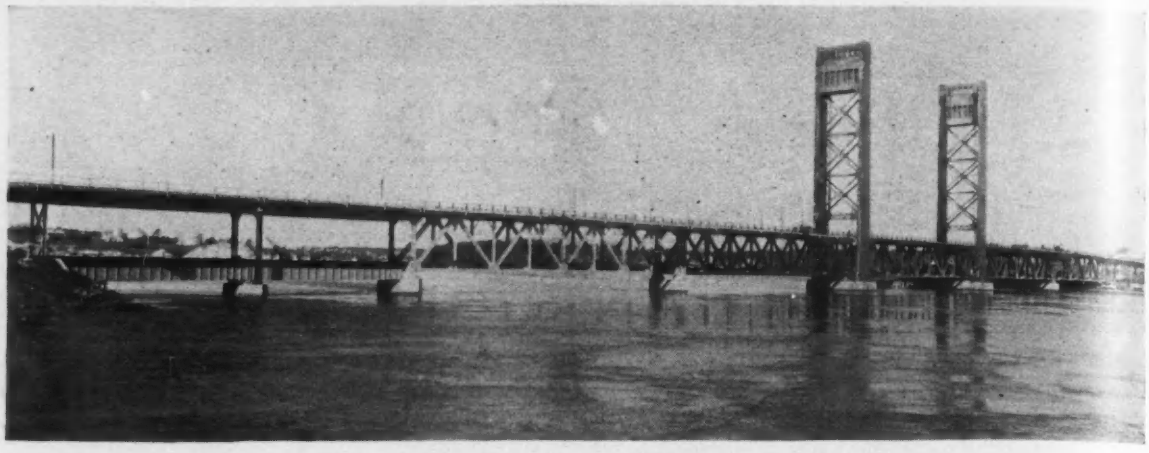
***Contents in Brief**—Double-deck highway and railway bridge over Piscataqua River at Portsmouth, N. H., is at a location where swift tides and deep water made falsework erection difficult. Solution was to set braced bents of hollow legs on the bottom and drive steel H-piles through these legs to rock. The piles averaged 100 ft. in length. Bridge loads were carried on the bents and transferred to the piles through a bolted connection.*

FOR MANY YEARS the historic city of Portsmouth, N. H., has formed a bottleneck for interstate highway traffic on U. S. Route No. 1, while the 100-year-old pile trestle and timber drawbridge there, carrying the eastern branch of the Boston & Maine Railroad over the Piscataqua River, was inadequate to serve rail traffic efficiently. Both of these unsatisfactory conditions were recently remedied when the Maine-New Hampshire Interstate Bridge Authority with the aid of PWA opened its new double-deck bridge between Portsmouth and Kittery, Me. In addition to being an important traffic artery the bridge is also of interest because of the erection scheme that was used, particularly a special falsework design to cope with swift, deep water.

The new bridge has a total length on the upper, or highway deck, of 2,798 ft.; a 30-ft. concrete roadway and two 3-ft. sidewalks are accommodated. The lower deck carries 1,606 ft. of single-track railroad. The main river crossing consists of a 224-ft. vertical lift span flanked on either end by two 225-ft. truss spans; towers for the lift span are 207½ ft. high. On the south bank of the river there are two 88-ft. deck girder approach spans, which carry the railroad, and fifteen deck plate girder spans, varying from 68 to 88 ft. in length, which carry the highway. On the north bank of the river six deck girder spans carry the highway, and three deck girder spans carry the railroad.

One of the architectural features of the bridge is the use of steel sheathing plates welded on the faces of the lift span towers. The lift span is operated by 100-hp. electric motors in machinery houses on each tower top, power being applied to the counterweight ropes and sheaves through a train of gears. Counterweights are of concrete incased in steel boxes. The two ends of the span are kept level by 50-hp. synchro-tie motors installed on the same shaft as the driving motor; a selsyn skew limit device prevents the lift span from getting more than 4 in. out of level. The bridge is controlled from an operator's house located on the fixed span adjacent to the south tower.

Superstructure erection was not unusual, a 25-ton traveler with 75-ft. boom, operating on the roadway deck, being used for the truss spans; a guy derrick mounted on skids, operating on the roadway deck, being used for the south approach girders; and a locomotive crane, operating on the ground, being utilized to lift the north approach girders into place. The truss span traveler also erected



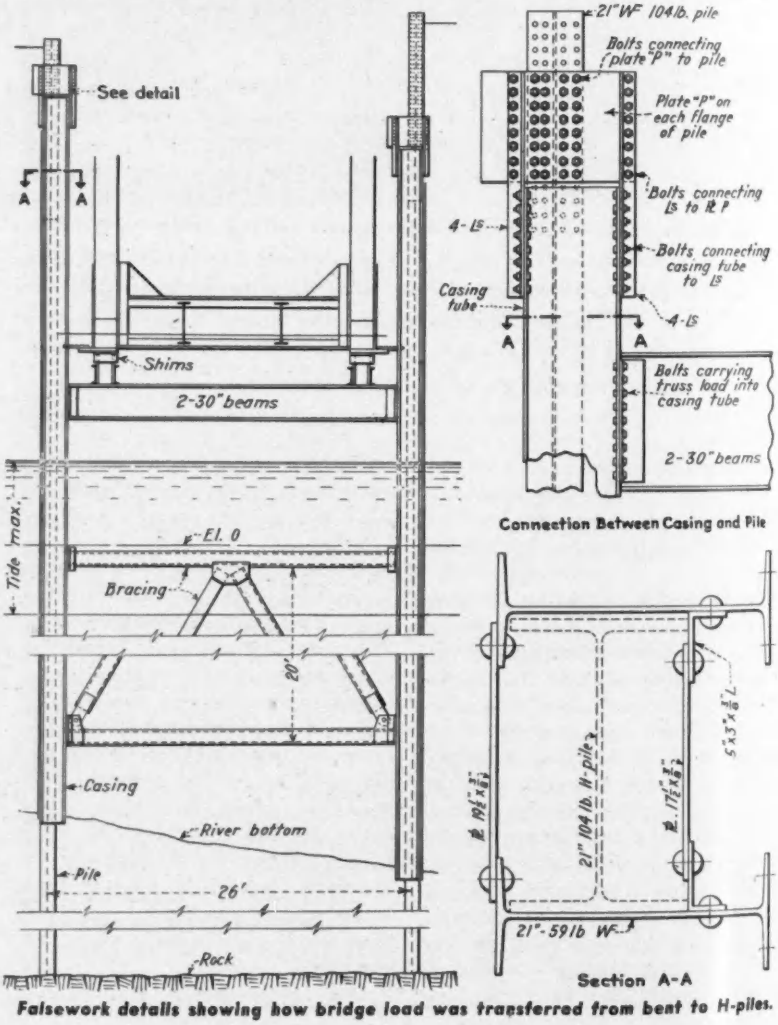
Portsmouth-Kittery Bridge completed. Highway is on upper deck, railway beneath. Lift span towers reflect care taken to achieve good appearance.

the lower half of the lift span towers, while the top halves were placed by guy derricks, supported at two successive levels on the tower itself.

The principal interest in the job rests in the falsework developed for the truss spans. Conventional bents could not be used because the Piscataqua River at the bridge site has an 8 to 10-ft. tide, a current of high velocity, a 60 to 70-ft. depth of water and a considerable layer of bottom mud overlying solid foundation. To meet these conditions, braced bents with hollow legs were prefabricated and set on the river bottom, after which H-piles were driven through the hollow legs to rock.

Since the five trusses including the lift span were of similar design and of eight panels each, one set of falsework was sufficient. This consisted of three bents, one at every second panel point for a span. The prefabricated bracing consisted of hollow legs or steel casings made of 21-in. 59-lb. H-sections and plates in 20 to 60-ft. lengths, making a total casing length of 80 ft. when required. These hollow legs were braced at 20-ft. heights in the transverse direction of the bridge but no bracing was used longitudinally. The piles driven inside the legs were 21-in. 104-lb. H-sections averaging 100 ft. in length and weighing 5 tons. Each pile driven was required to carry a dead load of 152,660 lb.; a traveler live load of 88,000 lb.; a tide overturning load of 48,000 lb.; and wind load of 105,000 lb.

In placing the falsework, the two hollow casings for a bent were assembled with the accompanying bracing on the upper deck of the bridge, the casing legs being adjusted to sounded depths by means of holes for the bracing in the casing legs. At a slack tide period the traveler picked up the assembled bent, moved forward and lowered it to rest on the bottom as shown in the accompanying illustration. Timber shores and crossed lashings from the bent top to a pier



Falsework details showing how bridge load was transferred from bent to H-piles.

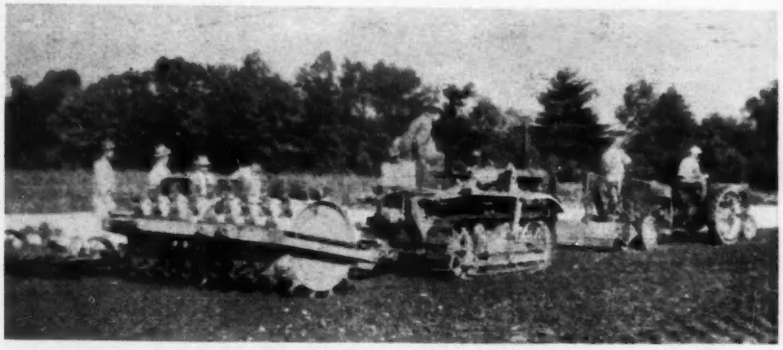
or to bents already placed were used to hold the new bent in correct position. The traveler then inserted the 21-in. H-pile in each casing leg and drove it to rock. After the bottom chords and the bottom laterals of a span were erected on a bent, the temporary wooden shores and lashings were removed.

Inasmuch as the bridge load was carried by a pair of 30-in. 108-lb. H-beams bolted between the casing tops, it was necessary to connect the casing with the piling in order to transfer the load to the foundation. This transfer of load was made at the top of the casing by means of adjustable plates and a series of holes drilled in the pile top as shown in the drawing. The bridge camber was obtained by shims between pedestals on the 30-in. beams and steel slabs bolted to the under side of the bottom chords.

After a truss span was erected and the bottom chord splices riveted, the falsework bents were freed by lifting an end of the span with hydraulic jacks on the pier. The traveler then removed the 30-in. transverse beams and the bracing between the hollow casings. After being disconnected from the piles, the casings were pulled up to provide access to the lower pieces of bracing. The pile sections were removed by the traveler at slack tide.

The total cost of the project was $2,477,369. The Phoenix Bridge Co., Phoenixville, Pa., held the superstructure work on a bid of $994,351. The substructure contract was held by the Frederick Snare Corp., New York, the north approach roadway by the Littleton Construction Co., Littleton, N. H., and the south approach roadway by John Iafolla Construction Co., Dedham, Mass.

Harrington & Cortelyou, Kansas City, Mo., were consulting engineers for the project with H. D. Peoples as resident engineer at the bridge site for the consulting engineers and the Maine-New Hampshire Interstate Bridge Authority. James R. Gardner was the chief resident engineer inspector for the PWA. The Phoenix Bridge Co. was represented in the field by J. F. Kinter, general superintendent of erection, Harry A. Archinal, field superintendent, and the writer as resident engineer. The falsework erection scheme was devised by William H. Ellis, assistant erection engineer of the company.



Rotary tiller, sheepsfoot roller, and spring-tooth harrow mix and compact soil cement runway at Westover Field, Northeast Army Air Base.

Soil Cement Runway for Army Airbase Placed With Enrichment in Top Inch

***Contents in Brief**—Low-cost runway construction at the Northeast Army Air Base used ten percent by volume of portland cement well mixed for a six-inch depth and the surface enriched by additional cement in the top inch. Heavy duty field cultivators and harrows, rotary tillers, sheepsfoot and tandem rollers and a bituminous distributor for application of water constituted the principal equipment required to give a density and weight equal to concrete.*

CONSTRUCTION of a soil cement runway at Westover Field, Northeast Army Air Base, Chicopee Falls, Mass., was completed last fall using only medium size machines yet securing efficient mixing to the 6-in. design depth. Removal of larger stones from the top and enrichment of the upper 1-in. of the runway with added cement gives the surface a smooth, weather-resistant texture. The runway on which the soil cement surfacing was applied is 150 ft. wide and 2,500 ft. long, and is an auxiliary landing strip for use pending completion of the permanent runways and for minor and storage use thereafter.

Soil cement is not recommended by the Portland Cement Association for heavy-duty runways and aprons but does offer a satisfactory surface for auxiliary and secondary runways and airports where first cost must be low. At Westover Field about 90 percent of unprocessed local material and the inexpensive procedure of in-place mixing were used to secure a runway surface at a contract cost of 54c. per sq.yd.

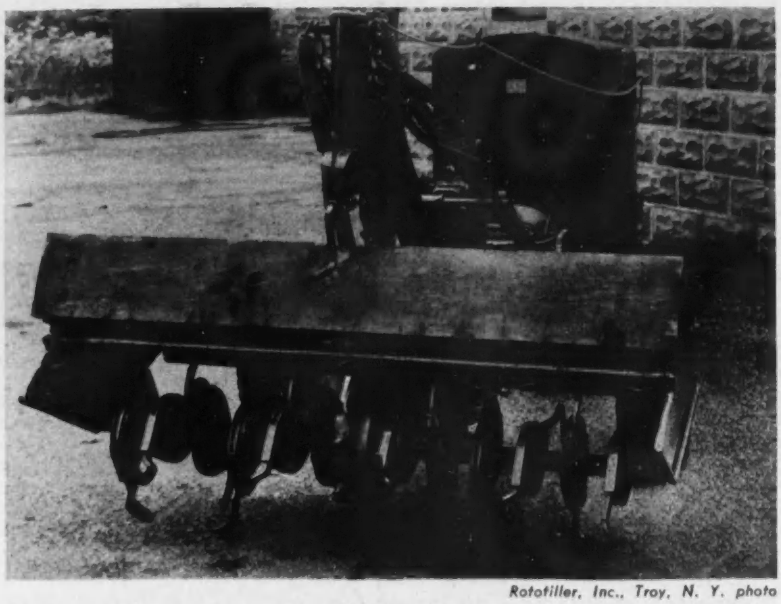
Base preparation

Prior to contract construction on the soil cement runway area, the WPA removed 6 to 18 in. of loam to expose a fine sand which extends to considerable depth. Soil for major portion of the mixture used was obtained from a nearby pit selected to avoid tannic acid and to provide a pit run material of sandy gravel with about 35 percent passing the ¼-in. screen and nothing larger than 3-in. This material was hauled to the runway in medium-size dump trucks and spread to a 7-in. uncompacted depth with not more than 0.1 ft. variation of surface above or below plan grade.

Contractor takes over

From this point the work was done under a competitive bid contract which required furnishing cement and all equipment for properly applying and mixing the soil cement of the runway. Lines, grades and inspection were handled by the Constructing Quartermaster.

The 150-ft.-wide runway was divided into 50-ft. strips for processing and the center section worked first for its entire length. An area about 600 ft. long constituted a usual day's work and this was definitely laid off by placing 8x8-in. timber headers across the end of the work with 2x8-



Rototiller, Inc., Troy, N. Y. photo

Garden variety, gas-engine-powered rotary tiller used to insure complete mixing to required depth.

in. side forms delineating the 50-ft. width. The timber forms were set with tops 2 in. above finished grade and held in place by wooden stakes and braces. This area was bladed to exact shape and grade, material being added or removed as required. It was then scarified and the material worked until it held within two percent of the optimum moisture required for proper mixing, water being added during this operation if required.

Early start

About 2 a.m. distribution of bags of cement started, a sack being dropped from a truck for each 2¼ sq.yd. of surface to give 0.1125 bbl. per sq.yd. or 10 percent by volume of compacted material. This was followed by crews spreading the cement, with hand shovels and rakes, over the allocated area taking the full length of the day's operation for ⅓ of the 50-ft. width in the first operation so that the machines could start on dry mixing. This mixing was done by tractor-drawn rotary mixers of a type developed from garden and truck farming tillers. The machines used (see illustration) were 48 in. wide and powered by a gasoline engine which operated a rotating shaft holding a series of knives. This machine churns up the soil and cement to the 6-in. depth required. This tiller is supplemented by an orchard-type cultivator, a long spring-tooth arrangement with cultivator blades, which was drawn by tractor. For work near the ends of the section two smaller rotary tillers of the true garden variety, with self-powered traveling and handlebar control were used, as they could complete the mixing right up to the headers.

Sufficiency of dry mixing was determined by eye with occasional test spots dug out to design depth to assure that mixing was secured to full depth.

Next operation was the use of a pressure distributor, of the type used on bituminous work, to apply a predetermined quantity of water. At Westover Field the engineers preferred 10 to 12 percent moisture, which was enough to make the rollers pick up the material. This amount of moisture is believed to produce better density, but probably requires more mixing, than the 7 to 9 percent of water favored by the contractor.

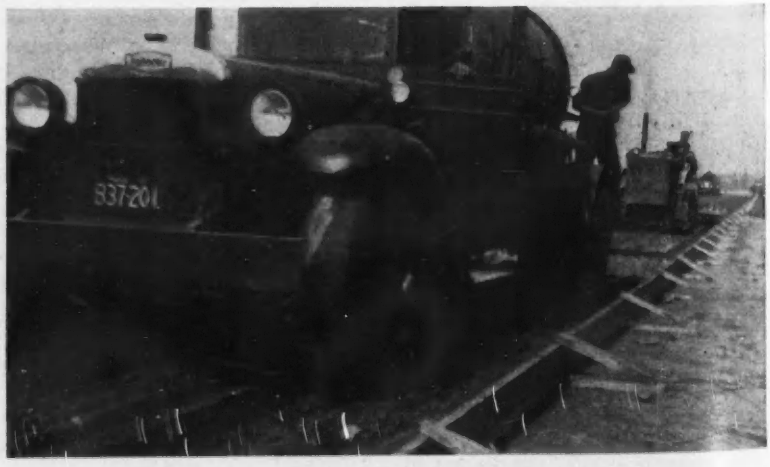
Wet mixing was done by the spring-tooth cultivators and rotary tillers, followed by sheepsfoot rollers which compacted the full 6-in depth. The resulting material had a weight of about 150 lb. per cu.ft., at least equal to that of concrete. A spike-tooth harrow follows the sheepsfoot roller, partially leveling the surface.

All stones 2 in. and over were next removed from the top 1 in. of the section being worked, by means of a surface maintainer with rake attachment. This oversize stone was loaded into trucks by hand and removed from the field.

At this point the header timbers used at the end of the previous day's operations were removed and the space filled with mixed soil cement taken from high spots of the area under construction. This material was tamped carefully into place. Previously completed work was then kept scrupulously clean and rolling operations carried over the joint to assure a smooth surface.

Surface enrichment

A surface mulch of enriched soil cement was used for the top 1 in. of surface. Additional cement was added at the rate of 1 bag of cement for each 20 sq.yd. of surface, uni-



Pressure distributor adds water, and tractor-drawn spring-tooth harrow starts mixing. Form, nailed to previously placed soil cement, keeps material and equipment off completed work.

Finished surface of soil-cement indicating texture of the enriched top layer. Black streak is rubber burn from fire on fast landing plane.

formly distributed by a sand or chip spreader. This cement was mixed into the surface by a spike-tooth harrow followed by application of a small amount of mixing water from the pressure distributor. The next machine used was the road maintainer with the stone rake, for shaping the surface to final contour, followed by a final pass of the spike-tooth harrow.

Rolling started at the low side of the 50-ft. strip, a 3-ton tandem roller making the first pass, followed by a 5-ton tandem and 15-ton three-wheel roller. The 15-ton roller pulled a wire brush drag over the surface to drag off the minor ridges and fill the hollows. The surface was then rerolled, the machines operating this time in 15, 5, 3-ton order with the smaller rollers being used to iron out minor surface defects.

Continuous operation was required from spreading of cement to completion of final rolling, accounting for the early morning start. About 6 hours were consumed for first spreading of the cement and the work of dry mixing. Wet mixing, addition of mulch topping, and rolling required time well into the evening and resulted in the suggestion that 24-hour-a-day operation would probably offer many advantages. Some lighting appears to be necessary anyway and continuous work would make full use of the equipment available.

The total cement used for the runway was 0.125 bbl. per sq.yd. or a bag for each 2 sq.yd. of surface.

Special care at joints

All through the work special precautions are taken to secure especially accurate construction along the longitudinal joints. Mixing was carefully checked; turning the material over with a gang plow was tried but did not appreciably improve the product. When water was distributed the spray bar arm was kept 1 ft. outside the work under way to wet the adjacent material and minimize its sponging effect.

The tractor treads were run very close along the joint to simulate sheepsfoot roller action where the rollers could not come close. When the 50-ft. sections on either side of the center were placed a 2x8-in. header board was set on top of the previously placed surface and held in place along the edge with braces nailed into the soil cement. These were removed at the time of final rolling and the joint lapped by the rollers, care being taken to keep the previously placed section free of stone.

Curing

Curing of a section started early on the day following its completion, with the placing of 4 lb. of hay per sq.yd., which was immediately wet down and then kept moist by the pressure distributor for a period of seven days. Moderate-size pneumatic-tired equipment was permitted on the surface the morning after placing.

The work was done under direction of Lt. Col. M. A. McFadden, then Constructing Quartermaster at Westover Field; M. R. Gilpin, Jr., chief engineer; C. S. Duncan, office engineer; J. F. Skidmore, field engineer; F. H. Connors, soil technician and I. A. Gelina, inspector in charge of soil cement work.

Contractor on the soil cement application was D. M. Winkleman Co., Syracuse, N. Y., for whom Larry Cain was superintendent.

Since the U. S. Engineer Dept. took over the construction at this field in December 1940, Carl H. Lovejoy is area engineer.

Uniformed Refuse Collectors Improve Public Relations

WEARING OF UNIFORMS by refuse collectors is required by many cities to increase morale of workers and attractiveness of the service to citizens and visitors according to a report of the American Public Works Association.

Among the cities requiring uniformed refuse collectors are included Austin and Dallas, Tex.; Brookline, Mass.; Erie, Pa.; Los Angeles; Montclair and New Brunswick, N. J.; New York City; Topeka, Kan.; Youngstown, Ohio; and Montreal, Ottawa and Outremont, Canada.

Uniforms are furnished by the city in Austin, Brookline, New Brunswick, and the three Canadian cities. The company contracting for collection of refuse in Topeka furnishes the uniforms. In New York City and Erie, however, uniforms are bought in quantity lots by the city and sold to workers at reduced prices. Employees of Dallas buy their on uniforms, with the city paying half the price of a heavy jacket worn during winter months.

Uniforms worn by refuse collectors in most of the cities are of dark material, usually khaki but sometimes dark blue. Several cities have special uniforms for summer and winter. In Dallas, during summer, each employee has three light-weight trousers and shirts, tailored in military style, and a cap. The winter uniform is of whipcord material, and consists of trousers, a shirt, and a heavy jacket.

Service Charges for Refuse Disposal

Chester A. Smith

Consulting Engineer, Burns & McDonnell Engineering Co., Kansas City, Mo.

***Contents in Brief**—In the search for revenue to operate expanding municipal obligations, consideration should be given to financing refuse disposal by means of service charges. Some 85 cities on the West Coast employ such charges but east of the Rocky Mountains less than a half dozen communities have adopted refuse disposal service fees. Experiences and schedules of rates from four California cities are given in the following analysis of practice.*

WHY ARE SO MANY CITIES deficient in rendering adequate refuse collection and disposal service? The principal reason is lack of funds. So many demands are made on the general revenue income of a municipality, that after "necessary" obligations are met there is little left for routine "housekeeping" tasks.

The adoption of service charges—revenue specifically earmarked for refuse disposal use only—seems to be the logical way to correct deficiencies. Peculiarly enough, 85 cities on the West Coast employ this method of financing but less than a half dozen municipalities east of the Rocky Mountains have appreciated its advantages.

Refuse collection and disposal is an individual service similar to water, light, and other utility service for which the consumer pays an amount dependent on use. And recently we have seen widespread use of sewer rentals as a means of financing construction and operation of sewage disposal facilities in lieu of recourse to general tax revenues.

Unlike the sewer system, the cost of collection facilities for refuse lies in the purchase of trucks, and this is relatively small as compared with the cost of miles of sewer lines. But operating costs of refuse collection are very high in comparison with the operating costs of a sewerage system. It works out that the cost of disposal of refuse per capita is approximately the same as cost of sewage treatment where a relatively high degree of purification is required.

Cost of collection

Refuse collection costs per ton vary widely as there are so many factors influencing the costs, such as regulations concerning separation, frequency of collections, topography of individual cities, street, alley or yard collection, local climatic conditions, length of haul to point of disposal and local wage scales.

Based upon information obtained from a number of typical cities, the collection costs ranged from $2 to $2.75 per ton for southern cities, and from $3.25 to $5.75 per ton for northern cities. Likewise incineration costs range from about $0.60 to $2.42 per ton, with a fair general average of $1 per ton. A general average cost of adequate and satisfactory collection and disposal of refuse would range from $4.50 to $5 per ton.

The amount of refuse, which includes garbage, trash and a moderate amount of ashes and other wastes, will average from 2 to 2.5 lb. per

Yesterday and today in refuse disposal equipment; the high lift, totally inclosed dump truck has a capacity of 35 cu.yd. To finance the purchase of modern equipment it is urged that cities adopt service charges.

At Fresno, Calif., the sanitary fill method of refuse disposal is employed successfully on a minimum charge of 45c per month for weekly collections.

capita per day, or about 1.2 tons per service per year; the cost is about $6 per average service per year, or 50 cents per month.

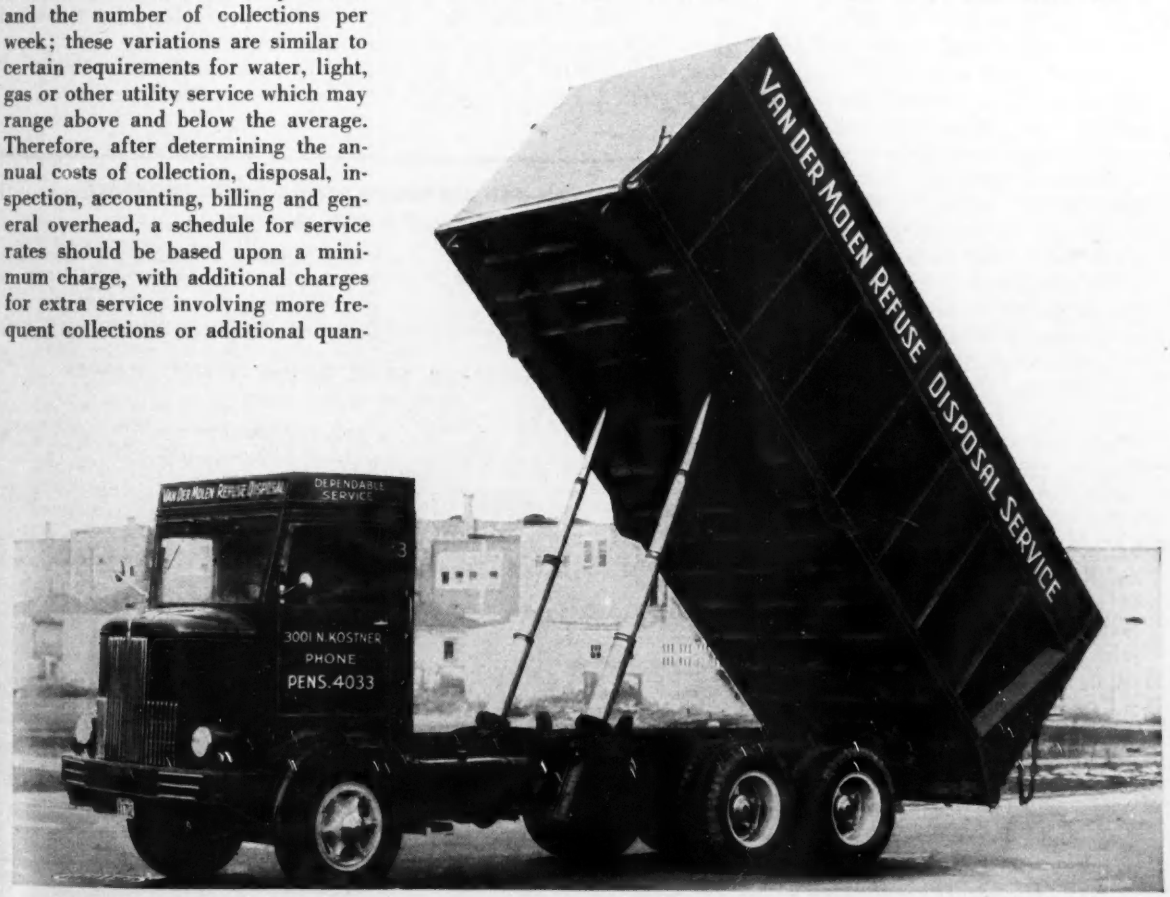
However, the amount of service varies with individual requirements as to the amount of refuse produced and the number of collections per week; these variations are similar to certain requirements for water, light, gas or other utility service which may range above and below the average. Therefore, after determining the annual costs of collection, disposal, inspection, accounting, billing and general overhead, a schedule for service rates should be based upon a minimum charge, with additional charges for extra service involving more frequent collections or additional quantities over the amount permitted under the minimum rate.

How charges are made

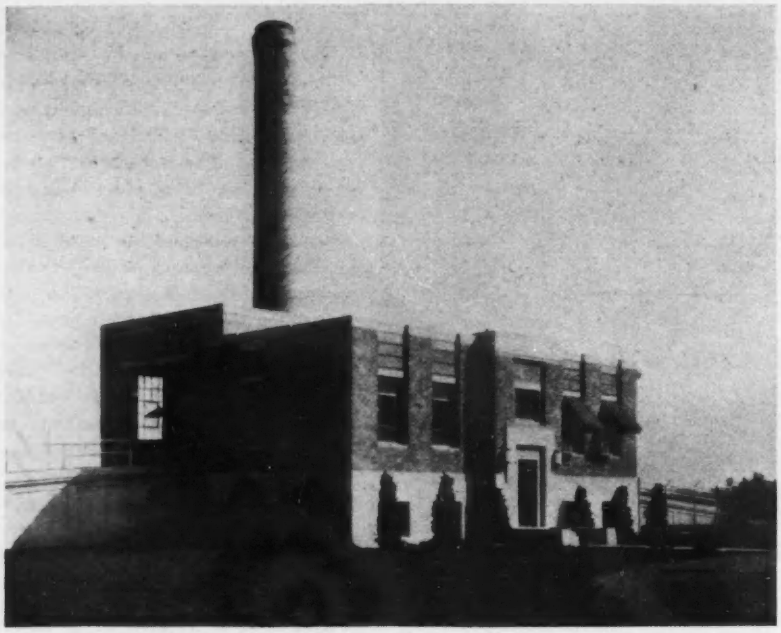
In some cities where service charges are made for refuse collection and disposal, a private company will be given a franchise to operate this service. In these cases the ordinance fixes rates, the requirements for type of collection equipment, sanitary regulations and other necessary restrictions. The contractor or private company bills and collects the service charges.

In other instances the municipality conducts the operations and the statement for refuse service is included with the water bill or other municipal utility statement. The following examples are given of cities where refuse service charges are made to illustrate some of the methods and schedules of rates in cities of from 19,000 to over 600,000 population.

San Francisco with 630,000 population, is the largest city where service charges are made for refuse collection and disposal. This city has the usual ordinance defining refuse and type of storage container, but has no separation classification and provides for the licensing, bonding and entering into contract for the collection and disposal of refuse, also fixing the schedule of rates for the various classes of service. In Table I are shown the monthly charges for



The Heil Co. photo



Complete disposal by incineration is the ultimate aim of every municipality. This plant, combining refuse incineration with sewage treatment, was built by Winfield, Kansas.

collections from residences and flats made from the ground floor.

Collections made from the second story are from 5 to 10 cents additional to the scheduled rates in Table I, and for third story collections an additional 5 to 10-cent charge is added to the second story rates.

A similar schedule is provided for apartment houses ranging from 10 to 600 rooms, starting at $1.40 per month for one weekly collection, to $2.40 for six collections per week for a ten-room apartment, to $68 per month for six weekly collections for an apartment of 600 rooms.

Special cases not included under the schedules are subject to agreement and contract between the producer and duly licensed collector. Charges for refuse service are collected by the licensed collector.

In Stockton, Calif., population 54,513, an ordinance defines refuse and its classifications, stipulates type of refuse receptacles, states regulations concerning disposal, and sets forth a schedule of fees. The city also grants a corporation the right to operate the collection and disposal systems and to collect the prescribed fees from the individual householders, stores, and other concerns.

The franchise ordinance provides a minimum license fee of $500 per month or 20 percent of the gross monthly receipts from fees. The license fees provide a revenue of at least $6,000 yearly to defray the inspection expense of the city. City trucks collect yard refuse such as grass cuttings, tree trimmings, etc., and in 1939 this service cost the city $25,000. The monthly rate schedule used in Stockton is given in Table II.

Experiences of Fresno

Fresno, Calif., population 60,650, operates the collection service and a sanitary fill method of disposal. No separation is required for the ordinary household refuse which includes garbage, bottles, cans, paper and other miscellaneous discarded articles. For one household collection per week of 30 gal. of mixed refuse, there is a charge of 45c. per month; if two collections weekly are desired the charge is 80c. In addition, the service includes one collection per month for the 45-cent customer and two collections for the 80-cent service of all garden rubbish, grass cuttings, tree prunings, etc., without limit to the amount of such material.

Fresno's gross revenue for the year ending June 30, 1939, was $119,240 for service charges and a total gross of $123,326 which included some salvage revenue and other miscellaneous items. The total operating expense for the same period including collection, disposal and administration was $108,744. A surplus of about $14,500 remained to be used by the municipality for a depreciation reserve.

Palo Alto, Calif. (pop. 19,000) contracts for collection service on a

TABLE I—SAN FRANCISCO REFUSE SERVICE CHARGES

Monthly rate for ground floor collection

No. of Rooms	Collections per Week 1	2	3	4	No. of Rooms	Collections per Week 1	2	3	4
1 to 4 inclusive	$ .40	$ .60	$ .90	$1.15	9	$ .70	$1.05	$1.20	$1.45
5	.45	.65	.95	1.20	10	.75	1.10	1.30	1.55
6	.45	.65	.95	1.25	11	.80	1.15	1.35	1.60
7	.60	.90	1.05	1.30	12	.85	1.25	1.45	1.75
8	.65	1.00	1.15	1.40					

TABLE II—STOCKTON, CALIF., REFUSE SERVICE CHARGES

Monthly rate for refuse disposal

Gallons	Collections per Week 1	2	3	4	5	6
30 or less	$0.50	$0.75	$1.00	$1.25	$1.50	$1.75
31 to 40	0.75	1.10	1.50	1.87	2.25	2.62
41 to 50	1.00	1.50	2.00	2.50	3.00	3.50
51 to 60	1.25	1.85	2.50	3.12	3.75	4.37
"		"	"	"		
101 to 110	2.50	3.75	5.00	6.25	7.50	8.75
"		"	"	"		
191 to 200	4.75	7.10	9.50	11.87	14.25	16.62

Rubbish and waste from business establishments:

Cu. Yd.	Collections per Week 1	2	3	6
0—¼	$0.75	$1.00	$1.25	$1.50
¼—½	1.25	1.75	2.25	3.00
½—1	1.75	2.50	3.25	6.00
For each additional ½ yd.	.50	.75	1.00	1.50

TABLE III—PALO ALTO, CALIF., REFUSE SERVICE CHARGES

Monthly rate for refuse disposal

Single Family Residences	
1 collection per week	$0.65 per month
2 collections per week	1.00 per month
3 collections per week	1.50 per month
6 collections per week	3.00 per month

Minimum charge—$0.65 per month.

Flats, Apartments & Bungalow Courts

	Collections per Week 1	2	3	6
For each apartment	$0.65	$1.00	$1.50	$3.00
For each additional apartment	0.25	0.30	0.35	0.40

Minimum charge—$1.00 a month.

Where apartment houses have incinerators which are maintained in good condition, a reduction of 70 percent of the above charges is made.

Business Houses

A flat monthly charge is made; the amount is based on amount of material removed per month.

yearly fixed sum basis. Service charge collections are made in connection with the water, electric and gas utilities.

The city ordinance defines and classifies "garbage" and "waste matter," places strict regulations on the individual householder as to storage receptacles, cleanliness of cans and premises, prohibits burying garbage or burning trash on premises in yard incinerators or otherwise, provides for licensing and bonding of collectors, specifies type of wagon and condition in which it must be kept, provides for sanitary inspection of premises, collections, equipment, etc. and provides for the Board of Public Works to make a schedule of service charges. All provisions of the ordinance from the individual's premises to final disposal (by sanitary fill) are rigidly observed and enforced.

For the year ending June 30, 1940, the collection costs per ton at Palo Alto was $3.74, which included payment to private collecting company, city office and accounting expense. The cost of disposal by sanitary fill was $0.68 per ton. Total revenue was $53,894, and operating expenses were $38,987; the net surplus after all expenses were deducted was $13,990.

These examples are indicative of what can be done in the establishment of service charges. A city governing body initiating a charge for refuse service will undoubtedly arouse considerable opposition from the citizens, but after the schedule is once established and the principles thoroughly understood, there will be a closer cooperation between the individual citizen and the municipality in promoting efficiency and economy in operation of collection and disposal and, most important of all, better sanitation and health conditions.

During the last few years there have been more rigid requirements and restrictions by federal and state health agencies concerning proper or required treatment of sewage, and it is almost inevitable that there will be similar demands made for more adequate refuse collection and disposal, hence the need for more money to provide this service. It seems safe to predict that service charges for refuse disposal will follow in the wake of the sewer rental charge which is already well established in a number of cities.

Accuracy of Transit Work Depends on Clearer Circle Graduations

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***Contents in Brief**—Comparative tests of four typical transits show large differences in accuracy, independent of line spacing or vernier count but dependent on clearness of the graduations.*

THE BOTTLENECK of transit accuracy is the difficulty of determining precise vernier readings. Unless the angles are repeated a minimum of twelve times, this difficulty accounts for the greater portion of the total error in the result.

Accuracy of vernier reading in turn depends on the clarity or *definition of the graduations*. Despite current belief, neither the spacing of the graduations nor the least count of the vernier has much effect on this source of error. As long as the vernier is read with the usual reading glass and the transits are comparable, a 20-sec. instrument is no more accurate than a 1-min. instrument.

Standard engineering transits, which usually have a 6½-in. horizontal circle, may give results differing as much as 65 percent in accuracy between different instruments, according to the definition of the graduations employed. Tests prove that unrepeated angles read on this type of instrument will in 10 percent of all cases vary over a range greater than 38 sec. of arc when the clarity of graduations is poor, while when the graduations are exceptionally clear this range is cut down to 23 sec. The corresponding errors of position of the end of a 400-ft. line are 0.08 ft. and 0.05 ft. respectively.

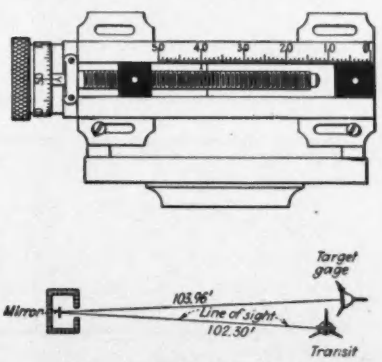

Fig. 1. Two targets with 0.23-in. white bullseyes were mounted on a hook gage fixed on a tripod to test the precision of transit settings.

Errors of such magnitude cannot be ignored. Even though they occur only 10 percent of the time they introduce serious uncertainty in giving line for construction or in making precise surveys.

Test devised

In order to determine the exact values of such errors a test was devised which, it is believed, eliminated all transit inaccuracies except that of setting the vernier and pointing the telescope. A hook gage mounted on its side on a transit tripod (Fig. 1) carried two targets, one fixed, and one movable, the movement of the latter being thus measurable to one

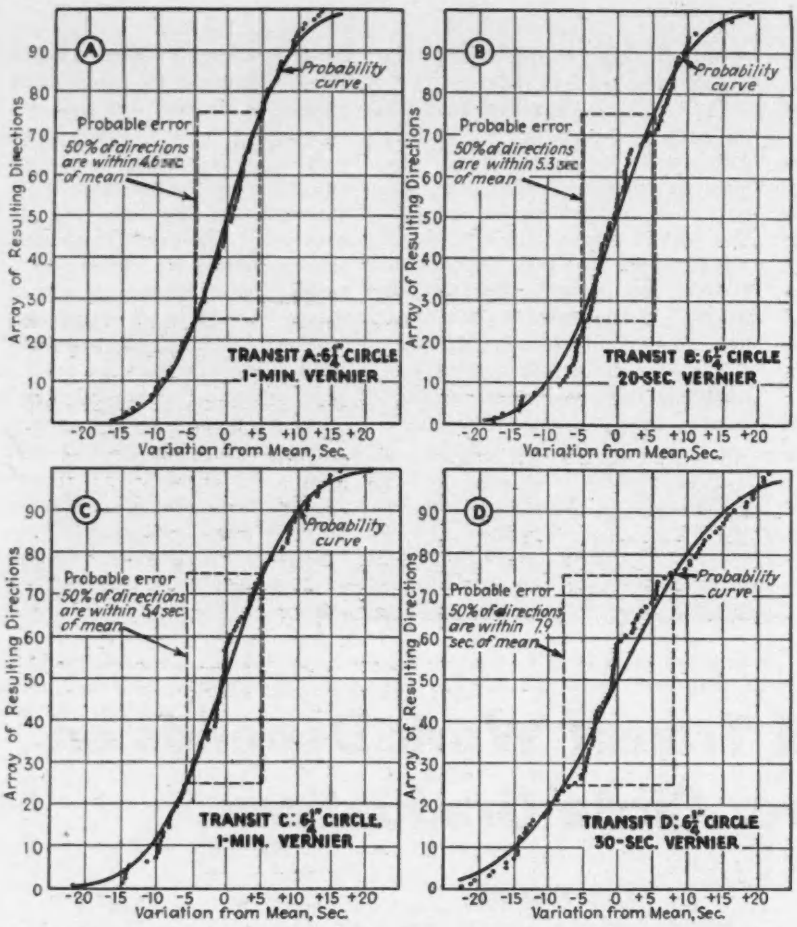
A
Probability curve
Probable error
50% of directions are within 4.6 sec of mean
TRANSIT A: 6¼" CIRCLE 1-MIN. VERNIER
B
Probability curve
Probable error
50% of directions are within 5.3 sec of mean
TRANSIT B: 6¼" CIRCLE 20-SEC. VERNIER
C
Probability curve
Probable error
50% of directions are within 5.4 sec of mean
TRANSIT C: 6¼" CIRCLE 1-MIN. VERNIER
D
Probability curve
Probable error
50% of directions are within 7.9 sec of mean
TRANSIT D: 6¼" CIRCLE 30-SEC. VERNIER
Array of Resulting Directions
Variation from Mean, Sec.

Fig. 2. Distribution of errors in 100 readings with each of four 6¼-in. transits shows marked differences in accuracy, the clearest graduations producing the most accurate readings.

ten-thousandth foot. The gage, set up beside the transit and observed in an optically flat mirror, was operated by the transitman while looking through the telescope.

The procedure was as follows: The vernier was set on a given graduation with the upper motion and the transit was pointed on the fixed target with the lower motion. An angle of 7 min. was turned with the upper motion. The movable target was brought on line by the micrometer screw of the hook gage, and the hook gage was read.

Both vernier settings were made carefully, using an ordinary reading glass. This process was repeated 100 times for each of four transits, all typical engineer's transits with 6¼-in. circle.

The results of the observations are shown by the plottings *A* to *D* in Fig. 2, in terms of seconds. Theoretical probability curves are also shown for comparison. The close agreement indicates the reliability of the results obtained in the test.

Range of inaccuracy

The accompanying table, made up from the curves, illustrates the range of inaccuracy that may be expected of a transit, and the important part played by clarity of graduations.

Angular error in seconds exceeded with the frequency indicated in the first column

	A	B	C	D
50%	4.6	5.3	5.4	7.9
40%	5.7	6.6	6.8	9.8
30%	7.2	8.2	8.3	12.0
20%	8.8	10.0	10.3	15.0
10%	11.4	12.8	13.3	19.0

The results of these tests indicate that when a transt is chosen for ordinary use (that is, when the angles are not to be repeated many times), it is essential that the graduations be studied with the greatest care. The perfection of the graduations is obvious to any experienced transitman after a few moments of study. The criterion is the speed and assurance with which he can estimate the vernier readings and the precision with which he can return to a mark using the vernier setting as a basis.

Long Cantilever in India

EXTREME WIDTH and a span of 1,500 ft., which is exceeded by only two other cantilevers in the world, characterize the highway bridge now under construction across the Hooghly River at Calcutta, India. With its trusses spaced 76 ft. apart, there is a 71-ft. roadway, having a double-track electric car line in the middle, while outside of the trusses are two sidewalks 15 ft. wide. For river craft the bridge gives a clearance of 30 ft. The trusses are 268 ft. deep over the piers and 85 ft. in the central suspended span. An unusual feature of the bridge is the fact that the roadway is suspended below the bottom chords of the trusses. As described briefly in the *Railway Gazette*, (London), the main span is composed of two cantilever arms of 468 ft. and a suspended span of 564 ft. The anchor arms are 325 ft. long, making a total length of 2,150 ft.

Many plans for a fixed bridge at this site have been proposed from time to time, as the old bridge is inadequate for present traffic conditions. But one great obstacle has been the fear that foundation work would disturb the flow of the river in its deep bed of silt, with consequent scour or erosion and possible interference with navigation. This difficulty is overcome in the new bridge by giving it so long a span that the piers are well away from the channel. The two main piers are concrete monoliths 181½ x 81½ ft., sunk to depths of 90 and 105 ft. by dredging through 21 wells.

The new bridge was designed by Rendel, Palmer & Tritton, consulting engineers, London, England. Its construction is being handled by the Cleveland Bridge & Engineering Co., of Darlington, England, and is under the supervision of A. M. Ward, chief engineer of the Calcutta Port Commission.

Turbulence in Open Channel Flow

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***Contents in Brief**—Laboratory experiments which provided a means of direct quantitative measurement of turbulence diffusion reveal new information on sediment transportation in streams. The following discussion outlines the general theory of diffusion in turbulent flow, describes the manner in which the measurements were made, and shows how the results can be used to practical advantage.*

INNER MECHANICS of fluid motion has been receiving considerable attention from engineers in various fields of work. The creation of turbulence, its growth, and its dissipation is of fundamental importance in problems of fluid motion involving friction and drag. Hydraulic engineers are familiar with the fact that turbulence increases the loss of energy in flowing water. Not all of them, however, are cognizant of the tremendous diffusive power possessed by fluid turbulence. The eddying nature of turbulent flow causes the rapid transference from one region to another of any foreign material that may be present in the fluid. Thus, the diffusion of smoke, water vapor, and dust in air would be insignificant if it were not for the diffusive power of turbulence. The transfer of heat, kinetic energy, and momentum from one region of a fluid to another would be very small indeed if it were not for turbulence.

To the hydraulic engineer the diffusive power of turbulence is of fundamental importance in problems relating to soil erosion, transportation of sediment, and sedimentation. The diffusive action of the turbulence makes possible the transportation in suspension of heavy particles by flowing fluids. Such transportation occurs in closed conduits or open channels; however, since the problems of sediment transportation by flowing water in open channels is of greater practical importance and interest, the present discussion will be devoted primarily to this problem.

Although much has been done in the study of sediment transportation in general, there has been little direct study of the diffusive action of the turbulence in water streams. This is a report of an extended series of hydraulic laboratory experiments in which direct quantitative measurements were made of turbulence diffusion. The theory presented and the basic results obtained are of general application to fluid turbulence; however, the experiments were conducted in open rectangular water channels, and thus the data obtained are of special significance for problems involving suspended material transportation in canals and rivers.

General theory of diffusion

Certain general concepts, of sufficiently sound physical basis, form the starting point for the development of the theory of diffusion in turbulent flow. One of these concepts developed by Prandtl states that unit shearing stress, τ, in fully developed turbulent flow is:

$$\tau = \rho \epsilon \, dU/dy \qquad (1)$$

where ρ is the fluid density, dU/dy the velocity gradient, and ϵ a coefficient of momentum transfer or diffusion. Since the unit shear at any point is dependent on channel slope, channel shape, and depth of flow, and the velocity gradient can be measured from the velocity distribution curve, it appears that ϵ can be determined fairly easily.

The rate of transfer of any foreign material is equal to DdN/dy where dN/dy is the gradient of the concentration of the material being transferred, and D is the diffusion or transfer coefficient due to the turbulence. The question arises as to whether ϵ, which characterizes momentum transfer, is identical to D which may characterize the transfer of sediment, water vapor, dust, smoke, etc. For the case of suspended material, if the mean sediment concentration N remains constant with respect to time, then the rate of transfer upwards by the turbulence is equal to the rate of dropping due to gravity. Therefore, we have:

$$cN = D \, (dN/dy) \qquad (2)$$

where c is the velocity of fall in still water of the sediment size considered. The integration of Eq. (2) and thus the determination of relative sediment concentration from top to bottom in a channel depends upon how D varies with y. So far D has been assumed to equal ϵ, as determined from Eq. (1), in obtaining expressions for suspended material distribution.

The diffusion coefficient has the dimensions of a length times a velocity. Analysis indicates that the length term is proportional to the "scale" of the turbulence; that is, the average size of the eddies. The velocity term is proportional to some average value of the transverse velocity component, v. This velocity, v, varies in a haphaz-

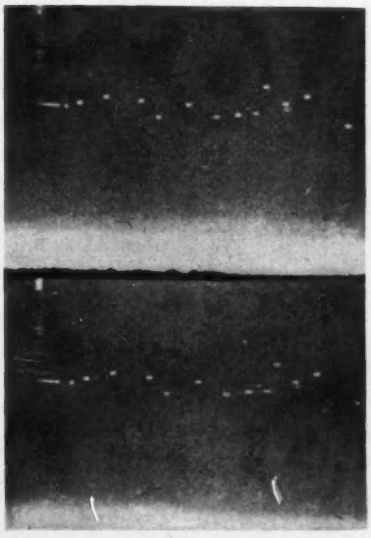


Fig. 1. Motion picture frames for study of turbulence.

ard manner with respect to time and its arithmetic average is zero. The root mean square average, $\sqrt{\overline{v^2}}$, is usually used to indicate the magnitude of the transverse velocity in turbulent flow, and is sometimes called the "intensity of the turbulence." (The bar over a term indicates a mean value).

Turbulence diffusion experiments

In order to study directly the variation of D with different hydraulic factors, it is necessary to make experiments on the diffusion of foreign matter in turbulent flow. If immiscible particles of the same density as water are injected at a point in turbulent flow, they will diffuse up and down and laterally in a manner dependent on the diffusive power of the turbulence. Such experiments were made in open channel flow by injecting at a point through a fine tube a mixture of carbon tetrachloride and benzine containing powdered anthracene.

Motion pictures were taken of the spread of the particles; individual frames from the film are shown in Fig. 1. At various distances, x, downstream from the point of injection, the value of $\overline{Y^2}$ was calculated, where Y is the vertical displacement of any particle from the injection level. The mean square of such distances for various values of x was obtained by reading the data from a large number of such pictures as shown in Fig. 1.

G. I. Taylor in analyzing statistically the diffusion process in turbulent flow gave the following equation relating $\overline{Y^2}$, $\overline{v^2}$, x, and U:

$$\frac{d\overline{Y^2}}{dx} = \frac{2\overline{v^2}}{U^2}\int_o^x R\,dx \qquad (3)$$

The term R is a dimensionless correlation coefficient which indicates how the velocity v of a particle at some point is related to its velocity v_x after the particle moves a distance x; it is defined as $\overline{vv_x}/\overline{v^2}$. The value of R must, of course, be unity when $x = o$, and in haphazard turbulent motion should approach zero as x becomes large. If the latter condition is true, then $\int_o^x Rdx$ becomes a constant for all values of x greater than x', at which value R is zero.

For large values of x, when $\int_o^x Rdx$ can be represented by a constant x_o, Eq. (3) can be integrated and we have:

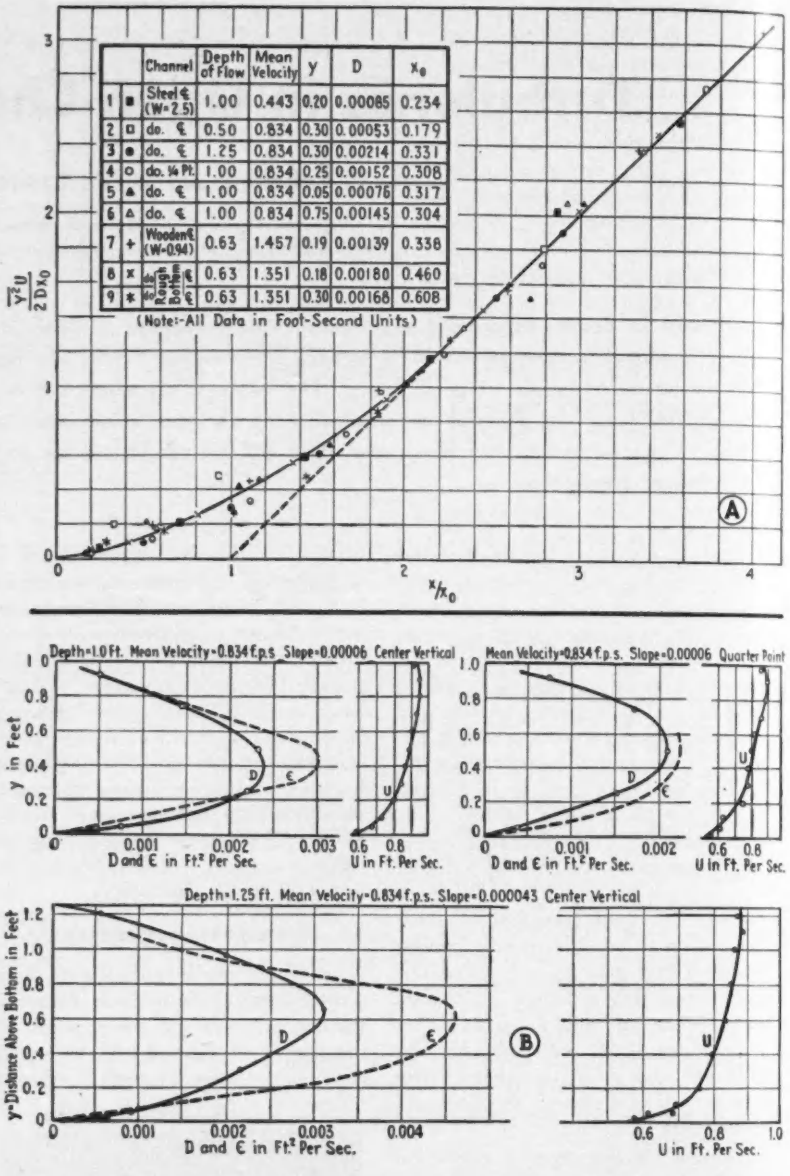

Channel | Depth of Flow | Mean Velocity | y | D | x₀
1 ■ Steel ℄ (W=2.5) 1.00 0.443 0.20 0.00085 0.234
2 □ do. ℄ 0.50 0.834 0.30 0.00053 0.179
3 ● do. ℄ 1.25 0.834 0.30 0.00214 0.331
4 ○ do. ½ Ft. 1.00 0.834 0.25 0.00152 0.308
5 ▲ do. ℄ 1.00 0.834 0.05 0.00076 0.317
6 △ do. ℄ 1.00 0.834 0.75 0.00145 0.304
7 + Wooden ℄ (W=0.94) 0.63 1.457 0.19 0.00139 0.338
8 × do. Rough Bottom ℄ 0.63 1.351 0.18 0.00180 0.460
9 * do. ℄ 0.63 1.351 0.30 0.00168 0.608
(Note:-All Data in Foot-Second Units)
$\frac{\overline{Y^2}U}{2Dx_0}$
x/x_0
A
Depth=1.0 Ft. Mean Velocity=0.834 f.p.s. Slope=0.00006 Center Vertical
Mean Velocity=0.834 f.p.s. Slope=0.00006 Quarter Point
y in Feet
D and ℄ in Ft.² Per Sec.
U in Ft. Per Sec.
Depth=1.25 ft. Mean Velocity=0.834 f.p.s. Slope=0.000043 Center Vertical
y=Distance Above Bottom in Feet
B

Fig. 2. Upper graph (A) shows striking correlation of turbulence diffusion from data obtained under a variety of conditions. The curves shown in B illustrate the variation of diffusion coefficients and mean velocity in a 2.5-ft. channel.

$$\overline{Y^2} = \frac{2\overline{v^2}x_o}{U^2}\quad (x - x_o) \qquad (4)$$

Thus, for large values of x, the relation between $\overline{Y^2}$ and x is linear and a plotting of data should give a straight line, the intersection of which with the x-axis gives the constant x_o. Taylor further proved that a diffusion coefficient could be defined as equal to $\frac{U}{2}\left(\frac{d\overline{Y^2}}{dx}\right)$ when x is greater than x'. This permits determining the coefficient, which we shall call D, from a $\overline{Y^2}$ versus x plotting by measuring the slope of the straight line. Therefore, it is noted that $D = \left(\frac{\overline{v^2}\,x_o}{U}\right)$ and thus Eq. (4) can be written after transposition:

$$\frac{\overline{Y^2}\,U}{2Dx_o} = \left(\frac{x}{x_o} - 1\right) \qquad (5)$$

The relation between $\overline{Y^2}$ and x for small values of x depends on the variation of the correlation coefficient R with x. However, it can be shown that no matter what this variation is the quantity on the left side of Eq. (5) must be some function of x/x_o.

In Fig. 2A is shown a plotting of

$\frac{\overline{Y^2}\,U}{2\,Dx_o}$ versus x/x_o, and it appears that the functional relationship is verified. What the actual mathematical relationship is between $\overline{Y^2}$ and x, for all values of x, is unimportant from any practical viewpoint. However, the fact that turbulence diffusion data obtained under a variety of conditions can be correlated in the manner shown is quite significant. The table in Fig. 2A indicates that the data were obtained from channels of two different widths, various roughnesses, different mean velocities, and a variety of depths. (The mean velocity given is that in the whole channel and y is the distance above the channel bottom. All data were taken in the center vertical section except run No. 4, which was at the quarter point).

Diffusion experiments of the type described permit determination of the diffusion coefficient D and the constant x_o, and since $D = \overline{v^2}x_o/U$, it is possible to calculate $\overline{v^2}$ the intensity of the turbulence. Thus, the diffusive power and the magnitude of the velocity fluctuations can be measured directly for turbulent flow without too much difficulty. Of course, the diffusion of salt, heat, or any other material might be used in place of the immiscible droplets used in the experiments.

Variation of coefficient

In open channel flow the main interest in the diffusion coefficient is in regard to its variation vertically from top to bottom, because of the importance of this item in suspended material calculations. Using the experimental method previously described, the diffusion coefficient D was measured for a variety of hydraulic conditions. After determining D, the value of ϵ was calculated from the shear and mean velocity gradient using Eq. (1) and values of both were plotted for comparative purposes. In Figs. 2B and 3A are shown these values in addition to the variation of the mean velocity from top to bottom for the section at which D was determined and ϵ calculated. In Fig. 2B, the data are for a channel 2.5 feet wide at different slopes, mean velocities, and depths of flow. In Fig. 3A the data are for a channel 0.94 feet wide with a larger slope, and two different bottom roughnesses.

The calculation of ϵ cannot be made very accurately because of the difficulty in estimating the unit shear at any point, and the inaccuracy involved in obtaining dU/dy from the velocity distribution curves, especially where the curve is almost vertical. However, it appears that the variation of ϵ and D are in general identical, and also that they probably have the same numerical values. Thus for all practical purposes in turbulent flow the coefficient characterizing the diffusion of momentum is identical to that characterizing the diffusion of foreign matter.

From the data it should be noted that the diffusion coefficient characterizing diffusion up and down approaches zero both at the bottom of the stream and at the top and this diffusion process is most intense at about mid-depth. Theoretical considerations indicate that this should be true.

For suspended material studies, in addition to knowing how the turbulence diffusion varies vertically, it is also of considerable interest to know something about the lateral diffusion process which tends to transfer sediment sidewise in a stream. The behavior of the eddies near the water surface is quite significant. Measurements of the horizontal diffusion coefficient were made near the surface for two different mean velocities in the center of the 2.5-ft. channel. The results are shown in Fig. 3B. Note that the lateral diffusion near the surface is greater than the maximum vertical diffusion. It appears, therefore, that the eddies which originate at the bottom on approaching the surface tend to spread horizontally and produce strong lateral diffusion. Practically this would indicate that because of the intense lateral mixing the sediment concentration across the stream in the upper part should tend to be fairly uniform.

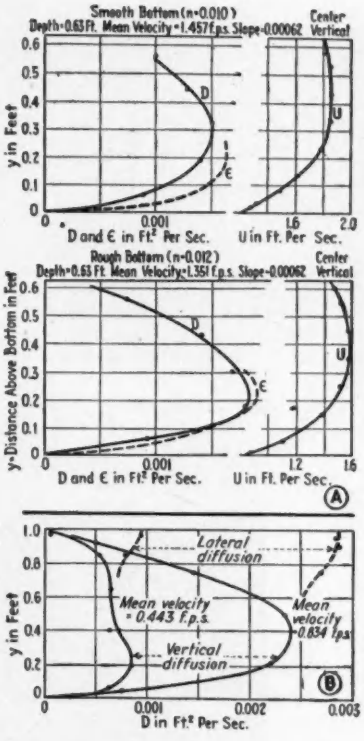


Fig. 3. Variation of diffusion coefficients and mean velocity in a 0.94-ft. channel are shown in the upper set of curves (A). Comparison of vertical and lateral diffusion coefficients for two mean velocities is given in B.

Conclusions

The conclusions drawn from the investigations are:

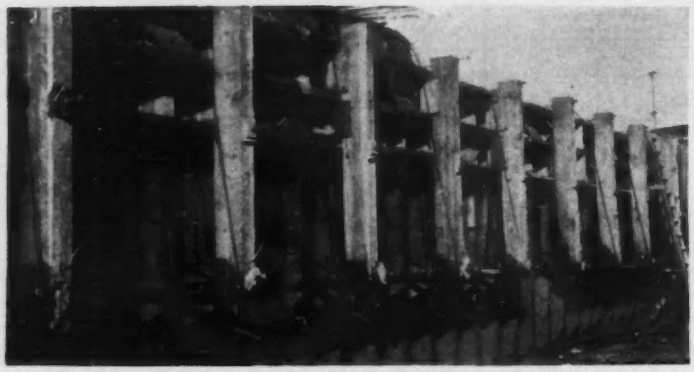
1. Turbulence in water streams can be quantitatively investigated by diffusion experiments. A turbulence diffusion coefficient and the intensity of turbulence can be measured from such experiments.

2. The momentum diffusion coefficient as calculated from the shear and velocity distribution curve is indicative of the ability of the turbulence to transfer sediment in streams and keep it in suspension.

3. The turbulence near the surface of a stream is such that it has a much greater ability to diffuse material laterally than vertically.

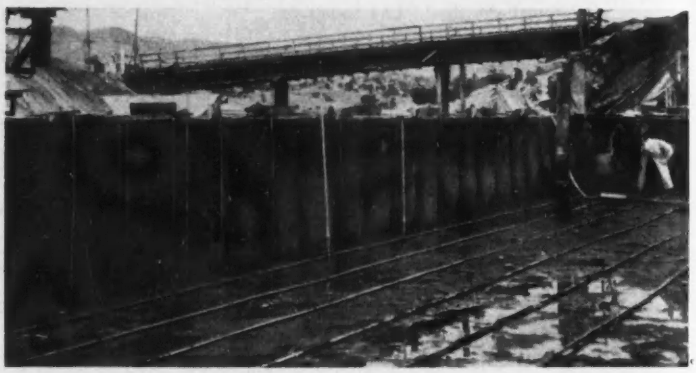
Transcontinental Railway For South America

A project for a new transcontinental line across South America to be formed by linking up existing railways for a route between Santos, on the east coast of Brazil, and Arica, on the west coast of Chile, was among the subjects discussed at the Pan-American Conference held recently at Havana, Cuba. Its total length would be 2,492 miles, with summit levels of approximately 14,000 ft. on part of the existing lines in Bolivia. There is a line in operation from Santos west to Corumba, at the Bolivian frontier, 1,106 miles, and an extension of 481 miles to Santa Cruz, Bolivia, is under construction by agreement with the Bolivian government. From Arica, on the Pacific coast, there is a line in operation eastward to Villa Villa, Bolivia, 588 miles.



Cantilever Forms at Friant Dam

***Contents in Brief**—Successful cantilever forms at Central Valley Project's Friant Dam utilize a connection just above the previously placed concrete to take the outward load and a special jack and tie at the bottom of the vertical cantilever member to provide properly aligned forms without interior ties. The forms are raised by chain jacks.*



Outside view, left, of panel form showing vertical timbers and connections carrying the cantilever load. At right, the inside view features absence of rods or struts for supporting the form. Vertical pipes are for grouting the contraction joint and horizontal pipes carry cooling water.

CANTILEVER FORM PANELS for mass concrete, something decidedly different in form design, are in use at the 2,000,000-yd., 324-ft.-high Friant Dam on the Central Valley Project in California. Advantages in doing away with troublesome fastenings inside of each form block are obvious.

Differences from previously attempted cantilever designs are largely in (1) placing the tiebolt which takes the tension pull above the previously placed concrete, (2) use of widely spaced vertical wales with three horizontal runners, (3) a special bolt made into a screw jack for alignment of the form, (4) unusually heavy construction with forms 50 ft. long and 10 ft. high designed for a 5-ft. lift of concrete placed in three hours' time.

The principal members of the forms are the 10x14-in. posts or timbers set vertically on 9-ft. centers. Through these posts go the 1¼-in. bolts inclining downward toward the inside of the form on a slope of 1¼ in 12, to be attached to anchors firmly embedded in previously placed concrete. There are three of these bolts in each post and the lower two are always firmly anchored in hard concrete when the form is in use. Between the two bolts and parallel to them is a threaded rod (near the lower bolt) which serves as a jack for adjusting the inner surface of the form panel to a truly vertical position.

Assurance of exact fit in each new position as the form is raised is obtained by the use of the third bolt, at the top, which serves as a dummy or spacer to which the next succeeding anchorage is attached when placed in soft concrete and left there as it hardens. As this top, or No. 3, bolt is exactly the same distance above No. 2 that No. 2 is above No. 1, the next bolt setting is sure to be in exactly the right location when the forms are raised (after the concrete has set for the required period).

Each form complete

Each form panel has three 3x12-in. longitudinal runners supporting an inner facing of wood 2 in. thick. On up and downstream surfaces the facings are smooth and are lined with a layer of moisture-absorbent material. On contraction joint panels the surface of the form against which concrete is poured has a keyed or corrugated facing which is covered with a wearing surface of 22-gage sheet metal. Each 50-ft. panel is complete, independent of other panels, and carries all auxiliary equipment needed in its adjustment and functioning. Thus when a panel is raised, everything for the new set-up goes up at one time. Attached to each panel are the water pipes supplying sprinkler heads that keep moisture on the recently stripped concrete surfaces and also chains that support plank platforms or scaffolds, hanging at the level of the lower edge. These platforms are used by workmen who make adjustments with the jacks to bring the forms exactly to vertical position.

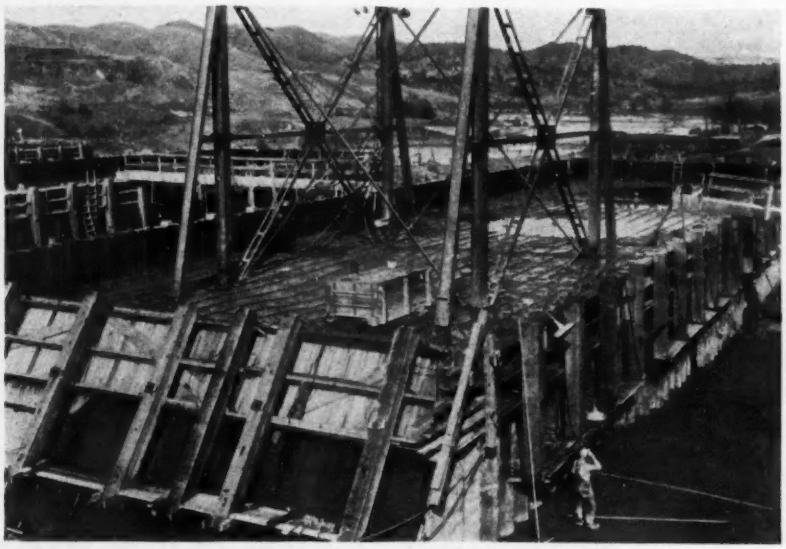
They are hung on chains to make it possible to swing them out of the way so that buckets coming into adjacent blocks can be swung up close to the joint. Water pipes in adjacent panels are joined by rubber

hose with simple connections made after the panels are fastened in each new position.

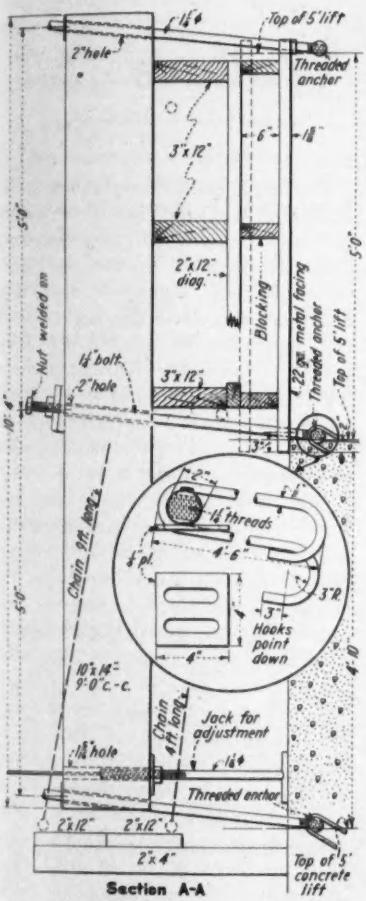
Handling

The original plan was to use the revolving cranes operating on the trestle to strip the panels. However, because these cranes can be used constantly in placing concrete, stripping is being done with hand-lever roller chain jacks and goose-neck A-frames. In stripping, the A-frames are set and the roller jack is tightened to hold the form while the bolts are removed. The form is then raised by the jack and the bolts inserted in the next row of anchors. The A-frames are held erect by other roller chain jacks (tied to the opposite side of the block) which can be adjusted to tilt the form as required to engage the bolts in the threads. Cables around the longitudinal runners are used for "pick-ups" on the form.

Concrete is mixed in 4-cu.yd. mixers in a plant at one abutment of the dam and is hauled out over the structure in 4-yd. concrete buckets on railroad cars. Two hammerhead cranes and two revolving derricks pick up the buckets from the rail cars and place the concrete directly in the dam. The cantilever form design was worked out by the Friant Dam contractors, Griffith Co. and Bent Co., operating under the general supervision of H. Stanley Bent as project manager. Friant Dam is being constructed by the Bureau of Reclamation.



Block formed for 5-ft. lift. Keys are used on contraction joint panels with up and downstream faces smooth and the form surfaces lined with absorptive material.



Section (above) through cantilever form with key. Below, typical outside elevation.

Production Peak Set for Electric Power

THE AVERAGE DAILY PRODUCTION of electric energy for public use reached an all-time high of 413,340,000 kwh. during October, the Federal Power Commission reports. This was 5.4 percent more than the average daily production in September and was an increase of 9.8 percent when compared with the same month of the previous year.

The total production of electric energy for public use during October was 12,813,530,000 kwh. of which 3,668,600,000 kwh., or 29 percent, was produced by water power.

Reports were received during November, 1940, indicating that the capacity of generating plants in service in the United States on Oct. 31, 1940, totaled 41,285,664 kilowatts. This is a net increase of 153,664 kw. over that previously reported in service on Sept. 30, 1940. Occasionally changes are made in plants which are not reported promptly so that the figures shown for any one month do not necessarily mean that all the changes were made during that month but only that they were reported to the commission since the previous monthly report was issued.

The total stock of coal on hand at electric utility power plants on November 1, 1940, was 12,506,516 tons. This was a decrease of 0.2 percent as compared with October 1, 1940, and an increase of 30.2 percent as compared with November 1, 1939.

Electric utility power plants consumed approximately 5,046,659 net tons of coal in October 1940, of which 4,812,235 tons were bituminous coal and 234,424 tons were anthracite, increases of 15.2 percent and 12.3 percent, respectively, when compared with the preceding month.

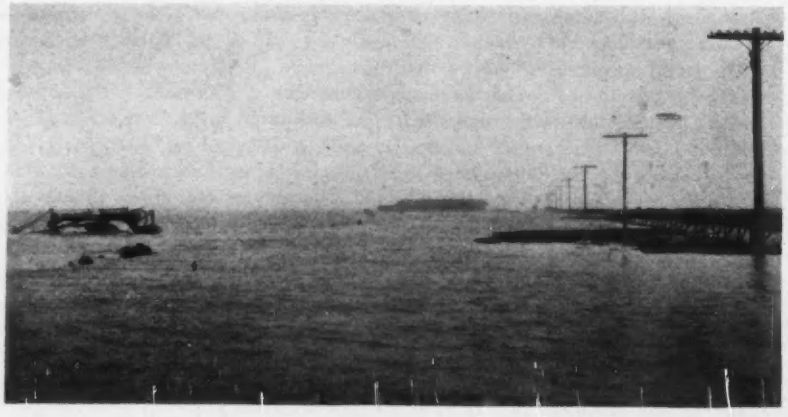
Tractor hauling trailer load of lumber mires down in Camp Wallace mud.

Fighting Mud at Camp Wallace

***Contents in Brief**—Biggest job in building Camp Wallace at Hitchcock, Tex., was to get into the site, for twice within a month flood water swept over the swampy low-lying coastal ground near Galveston Bay. Use of seven million board feet of planking for corduroy roads, sawmill and lumber yard paving got the job started. Four canals, a levee system and a dredged bayou now provide drainage and flood protection. All utility trenches had to be sheeted. Wood pedestal posts replace usual concrete pillars.*

IN THE low-lying, wedge-shaped plot of ground hemmed in by two main concrete highways from Houston, which converge into the approach to the Galveston causeway, lies Camp Wallace, opposite the village of Hitchcock, Tex. Drainage from 9,000 acres of higher ground to the west flows across the south end of the 1,590-acre camp site. That the drainage reaches flood proportions was discovered on two occasions, when a 9-in. rain on last Nov. 25 was followed by a 6-in. downpour on Dec. 12. Both storms flooded the site with 3 ft. of water. Flood protection, drainage, access across swampy ground, and foundation and trench excavation in soft muck became the chief problems of the camp builders.

No wonder it was muddy, for twice last fall the camp site looked like this as flood waters swept over the low-lying site. Temporary office buildings in the distance were an island in a big lake.



The main camp area, about 5,300 ft. square, is divided into three parts: the eastern third contains barracks and the hospital group; the west third includes more barracks and headquarters, while the middle is a full-length parade ground 1,612 ft. wide. To the south lies a drill field 2,771 ft. wide and 4,750 ft. long, the northwest corner of which is developed as a warehouse area. The sewage treatment plant is to the west of the drill field. There are 391 buildings in the cantonment, all of temporary construction. The City of Galveston main water line from reservoirs to the north to the city was tapped for the camp water supply. A 16-in. high-pressure gas line crossing the camp furnishes gas for heating, and an electric high line through the area furnishes power. Few camps have such convenient utility sources.

Permanent main roads are 30 ft. wide, secondary roads 20 ft. wide and service roads 12 ft. They are built of 18 to 24 in. of shell compacted by traffic to 9 and 12-in. thickness. It was originally planned for the main roads to be paved with concrete and the secondary and service roads to receive an asphalt surfacing, but this was eliminated for reasons of economy. The camp highway system includes a 3,000-ft. approach from Texas Highway No. 6 and about 15.4 miles of main and service roads. A 9,000-ft. railroad spur with branches enters the warehouse area.

The site is fairly level, sloping from El. 17 at the north end to El. 14

at the south border. It was largely waste land, part being used as hay meadows. Soil consists of 3 ft. of heavy black gumbo overlaying a clay. This clay is watertight, but the gumbo soaks up and retains water, becoming a black morass after a flood or hard rain. The nearby state highways are at El. 16.9. Building floors are set uniformly at El. 18, above the flood levels of last fall. All roads and streets are built up on original ground level. Sidewalks are miniature shell roads. All building foundations are carried down into the clay. Water lines are only 3 ft. deep, lying on top of the clay, but sewers are deeper. Because of trenching difficulties, sewer grades were broken at three places with pump lifts to keep the lines from going too deep.

Rail and timber road access

The contractors and engineers were hired on Nov. 2, and ordered to start work Nov. 6. Galveston County agreed to build a 3,000-ft. access road from the state highway to the site, and started work at once grading up the black muck and topping the road with mud (unwashed) shell.

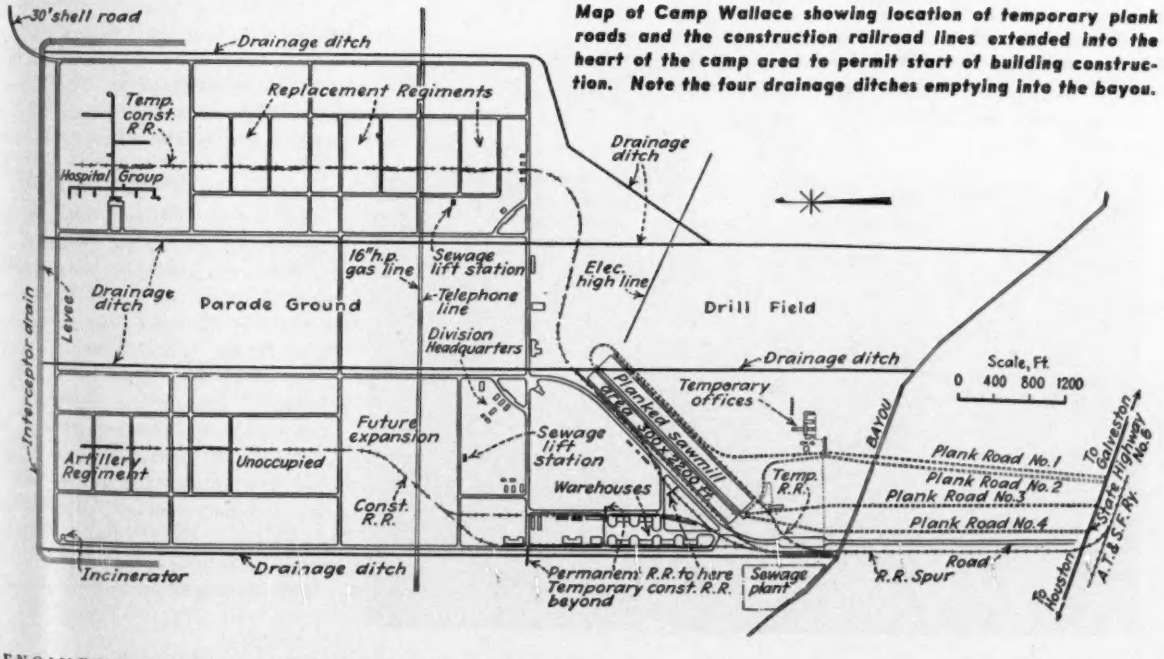
Meanwhile the contractor started construction of temporary offices and warehouses at the south end of the site. The county-built road went to pieces under traffic and heavy rains, and practically disappeared in the floods caused by the deluges of Nov. 25 and Dec. 12.

Plank roads provided access across the muddy flats, but required seven million feet of lumber.

After the floods subsided it was apparent something else had to be done to provide access to the site across the black morass. Taking a cut from Texas oil field road construction, the contractors built four one-way plank roads from the state highway to the temporary office area, then extended them to encircle the sawmill and lumber yard area. These roads consisted of 3-in. rough planking, 12 ft. long, laid transversely on 3-in. longitudinals which were laid directly on the mud.

On top of this planking were laid longitudinal runways of 3-in. plank 10 to 16 ft. long. A 3-in. high curb of single planking was placed along the inner side of each wheel runway to act as guards. These plank roads served so well the contractor decided to pave the entire sawmill and lumber yard area, 300x2,200 ft., with three layers of planking, and later they did the same to the sewage plant area. Nearly 7,000,000 b. ft. of lumber was used for the roads and area paving. The planking stood up under heavy truck traffic.

Thus, access was provided to the office and sawmill area, but access to the main camp, from 1 to 2 miles away, still was impossible as the rains continued. It was then decided to rush the permanent railroad spur into the warehouse section, 6,000 ft. long, and extend the railroad for 25,500 ft. as two temporary branches tapping the center of the two barracks areas. In building the railroad, both permanent and temporary lines, the original soil was not disturbed, but a heavy ballast of washed shell was built up over the muck. This shell, as well as that for the roads, came from a reef 30 miles out in the gulf, being transported by barge to the shore town of Dickinson, where it was reloaded into trucks. From the tem-



Map of Camp Wallace showing location of temporary plank roads and the construction railroad lines extended into the heart of the camp area to permit start of building construction. Note the four drainage ditches emptying into the bayou.

Creosoted ties fastened to wood disk bases replaced the usual concrete piers as building foundations. Concrete or aggregate delivery to building sites was impossible because of the mud.

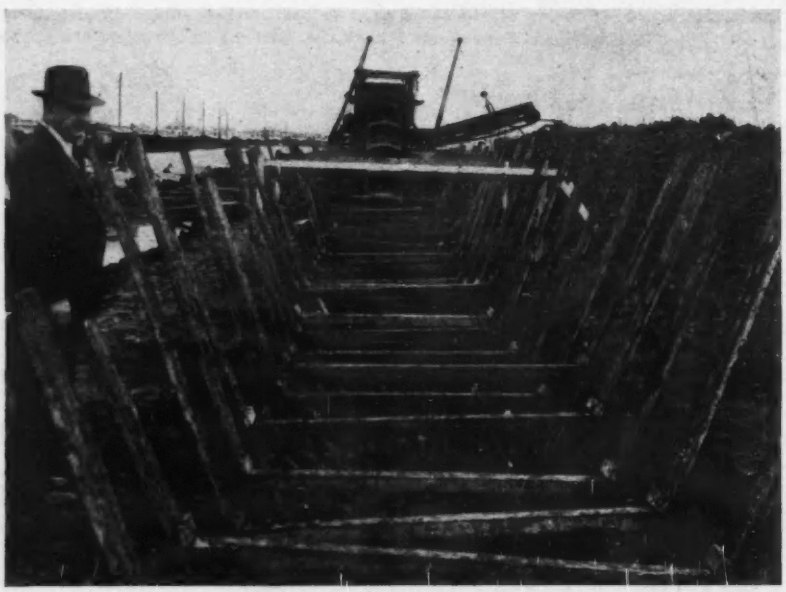
porary railroad to the location of early building construction, materials were hauled through this mud by tractors and teams. As fast as possible the permanent roads were built.

Drainage

A narrow, choked-up bayou at sea level ran from Galveston Bay to Hitchcock, and from Hitchcock a narrow drain ditch extended past the lower end of the camp site. This ditch is being dredged out, deepened to sea level and enlarged by draglines to provide drainage of the entire cantonment. Four main canals or ditches running north and south on both sides of the two barracks areas were excavated for local drainage. Spoil from the outer ditches was piled up to the outside to form levees. Another ditch, running east and west, was dug as an intercepting drain across the north end of the site. Its spoil forms a levee to the north; thus three sides of the camp are protected against floods by levees, and the south side faces the bayou. The engineers feel the camp is now safe from all floods, though the grounds are certain to become extremely muddy with each hard rain.

Excavating miles of trenches in the soft muck for utilities was a problem. Hand excavation was too slow and expensive; trenching machines bogged down and the trench sides caved in as fast as excavated. Finally, it was found that by operating the trenching machines slowly, sloping the trench tops by hand directly behind the machine, and immediately bracing the ditches with sideboards and struts (see illustration), fair progress could be made. Most of the trenches were excavated in this manner. Pipelaying followed close behind excavation, for the banks sloughed off between the sideboards within a few minutes.

Only by sloping the sides and slapping in shoring immediately behind the excavator could trenches in the soft muck be kept open long enough to get utility pipe in place.



Concrete foundations were necessary for the warehouses and other large buildings. Aggregates were hauled in by all possible means, including by wheelbarrow, to get the work started. However, it was virtually impossible to get aggregates to the thousands of pedestals and piers for the barracks, mess halls and other small buildings. Not only was the aggregate haulage a big difficulty, but the pier holes, dug with a tractor-mounted earth drill, would not stay open long enough to get the forms in place. Therefore, 8x8-in. creosoted timbers, fastened to a circular wooden mat or foot block (see illustration), were substituted for the conventional concrete piers. Soon the available supply of creosoted timbers were exhausted, but a supply of 7x9-in. treated railroad ties was found. Most of the buildings rest on such foundations.

In setting the wooden piers, the foot blocks were attached to the timbers in advance. As fast as the drill bottomed a hole, about 6 ft. deep, a couple of buckets full of cement grout were poured in the hole and the wooden piers were set in place before the hole caved in. The timbers were sawed off to grade later.

Direction

Major J. H. Miller is constructing quartermaster on the project for the Army. Architect-engineers are the combined firm of H. R. F. Helland and F. T. Drought, engineers, and Atlee B. and Robt. M. Ayres, architects, all of San Antonio. H. R. F. Helland is resident engineer in charge; J. B. Dannenbaum is his assistant. The cost-plus-fixed fee contract for all construction is held by the combined firm of Wohlfeld-Dalton-Dellone, all of Dallas. Nathan Wohlfeld is project manager for the contractors, assisted by Fred Dellone, Jr.

Wind Oscillations of Suspension Bridges

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***Contents in Brief**—Consideration of the aerodynamic principles involved in the Tacoma Bridge disaster requires knowledge of the values of lift and torque coefficients, which can be obtained by models. Oscillations, which occur in deck systems, originate in eddy currents, and when the natural frequency of the eddies under increasing wind velocities attains resonance with the natural frequency of the deck the oscillations increase enormously. Stiffening girders, even when streamlined, are more apt to form undesirable eddy trains than open trusses.*

THE DESTRUCTION of the floor system of the Tacoma Narrows Bridge due to torsional oscillations, and discussions of vertical undulations on the floor systems of the Whitestone, Thousand Islands and Deer Isle bridges have tended to make engineers acutely conscious of the importance of the problem of predicting the oscillatory motions of existing and future suspension bridges during strong winds. What are the factors that initiate the annoying vertical undulations and permit destructive torsional oscillations to be built up? What, in brief, are the dynamic and aerodynamic principles that are applicable?

These principles may best be presented in concise form by making certain simplifying assumptions whose deviations from actual conditions are not unreasonably great, and by choosing for illustration a structure in which the vibrations of the main span are independent of those of the towers and side spans. After grasping the fundamental conceptions involved in the treatment of this simplified case, an engineer with suitable training will not have difficulty in extending the analysis to more complex cases. The formulas presented here are, therefore, based on the assumptions that the towers are rigid, the cables and suspenders are non-extensible, the stiffening girders are hinged at the ends of the main span, the dead load per horizontal foot is uniform and the torsional rigidity of the pavement and other elements, except the vertical rigidity of the girders, is negligible. The wind is assumed as horizontal, normal to the structure and steady, except where unsteadiness is specifically mentioned.

Lift and torque coefficients

At times when the floor of a suspension bridge is tilted from the horizontal, the aerodynamic forces and couple per linear foot consist of a drag D, a lift L, and a torque T, the positive directions of these being indicated in Fig. 1. In accordance with usual practice the lift and torque are expressed by the formulas

$$L = C_L ub\frac{v^2}{2g} \text{ and } T = C_T ub^2\frac{v^2}{2g}$$

where b is the breadth of the bridge between suspender planes, u the weight of a unit volume of air, v the wind velocity and g the acceleration of gravity. The terms C_L and C_T are known respectively as the "coefficient of lift" and the "coefficient of torque," and are functions of the tilt angle θ. For small values of θ the value of C_T can be expressed in the form $k\theta$, where k is a constant.

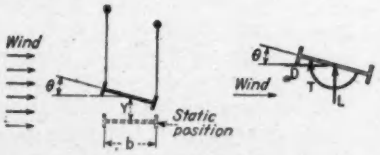


Fig. 1. Action of wind on a suspension bridge deck, with the forces that result.

Complete published data regarding the values of C_L and C_T for existing bridges appears to be lacking. Dr. Bowers' article (*ENR*, Nov. 21, 1940, p. 674) gives curves showing C_L as a function of θ for the original floor-and-stiffening system of the Tacoma Narrows Bridge, and for various proposed modifications thereof, but does not give corresponding curves for C_T.

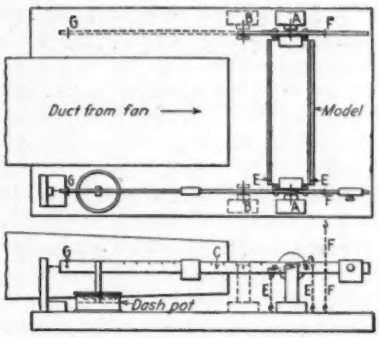


Fig. 2. Apparatus for testing aerodynamic properties of small models simulating floor-and-stiffening systems.

Fig. 2 shows an apparatus used by the writer in testing a small wooden model of flat H-beam shape, simulating the essential aerodynamic characteristics of a suspension bridge floor with vertical plate girder stiffeners. By pivoting the model at AA the values of C_T could be obtained directly, while by shifting the supports and pivots to BB, a combined effect of lift and torque was measured, from which the values of C_L were readily separated. During these tests the rubber bands EE and FF were removed.

Fig. 3 gives the curves of C_L and C_T for this model. The former curve confirms the results obtained in the wind-tunnel tests of the original Tacoma Narrows Bridge model, indicating negative values of C_L for small positive values of θ and positive values of C_L for larger positive values of θ. The curve for C_T brings out the remarkable fact that this coefficient is negative for all positive values of θ within the range investigated. In other words the wind torque always tends to restore the floor toward its horizontal position, this being accounted for by the sail effect of the windward girder and the pocketing effect of the leeward girder. This indicates that Dr. Von Karman's an-

alysis (*ENR*, Nov. 21, 1940, p. 670) establishing a critical velocity beyond which the torsional oscillations increase without limit is not applicable to suspension bridges with plate girder stiffeners, since that analysis postulates positive values of C_T for positive values of θ. Tests in the apparatus of Fig. 2, using a model of a flat rectangular section, simulating a floor system without stiffeners, give positive values of both C_L and C_T for positive values of θ.

Nature of the oscillations

Before discussing the origin of the oscillations caused by wind in suspension bridges, a brief reference may be made to their nature. By standard methods of mechanics it can be shown that, under the assumptions previously mentioned, the floor of the main span can oscillate steadily, either vertically or torsionally, in a series of equal loops separated by nodes. The equation for the vertical undulations is

$$y = 2y_o \sin\frac{n\pi x}{l}\cos\left[n\pi t\sqrt{\frac{2n^2\pi^2gei}{wl^4}+\frac{g}{8s}}\right] \quad (1)$$

and the equation for the torsional oscillations is

$$\theta = 2\theta_o \sin\frac{n\pi x}{l}\cos\left[\frac{n\pi tb}{2r}\sqrt{-\frac{4kuv^2}{n^2\pi^2w}+\frac{2n^2\pi^2gei}{wl^4}+\frac{g}{8s}}\right] \quad (2)$$

where l = length of main span, s = cable sag in main span, x = abscissa to any section, measured along floor from origin at end of main span, y = vertical deflection of center line of floor at section of abscissa x, θ = angle of tilt at section of abscissa x, y_o = amplitude of vertical deflection at center of a loop, θ_o = amplitude of tilt at center of a loop, n = number of loops in which main span is oscillating, w = dead weight per linear foot of bridge (including average weight of cables and suspenders), i = moment of inertia of cross section of one stiffening girder about its horizontal neutral axis, r = polar radius of gyration of floor-and-stiffening system in plane normal to axis of bridge (sum of quadratic moments of all weight elements divided by the sum of these elements), t = time and e = coefficient of elasticity of stiffening girder metal.

These equations indicate that both the vertical undulations and the torsional oscillations are sinusoidal in form and simply harmonic in history.

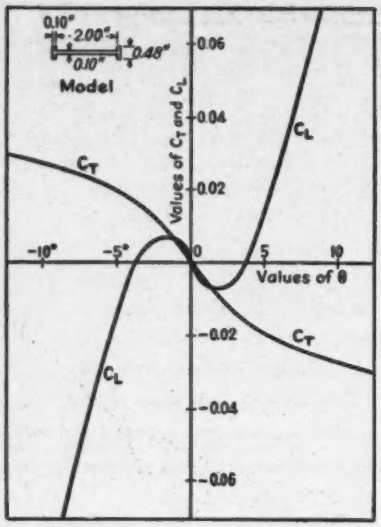


Fig. 3. Coefficients of lift and torque for small I-beam-shaped model.

The frequency f, or number of oscillations per second, is given by the following expressions:
For the vertical undulations

$$f = \frac{n}{2}\sqrt{\frac{2n^2\pi^2gei}{wl^4}+\frac{g}{8s}} \quad (3)$$

and for the torsional oscillations

$$f = \frac{bn}{4r}\sqrt{-\frac{4kuv^2}{n^2\pi^2w}+\frac{2n^2\pi^2gei}{wl^4}+\frac{g}{8s}} \quad (4)$$

It is to be noted that the wind velocity v affects the frequency of the torsional vibrations but does not affect that of the vertical ones.

Since $\frac{1}{2}b$ is greater than r in all ordinary cases, the frequency of the torsional oscillations is greater than that of the vertical ones even when the wind velocity v is zero. Since k is negative for suspension bridge floors with vertical longitudinal stiffeners of the plate girder type, as indicated in Fig. 3, the first term under the radical in Eq. 4 becomes positive, and therefore, in such structures, as the wind velocity increases, the frequency of the torsional oscillation becomes much greater than that of the vertical oscillation corresponding to the same number of loops.

Importance of eddies

The forces which initiate the oscillations and cause them to occur in a given number of loops and to attain certain amplitudes originate in the eddy system of the swiftly moving air surrounding the structure. The nature of these eddies may be investigated by immersing the H-beam model of Fig. 3 vertically in moving water whose surface is sprinkled with particles of talc. The eddy system, when the H-beam is inclined at a slight angle θ to the direction of the current, is sketched in Fig. 4. Large eddies trail alternately from the leeward faces of the girders, composing the vertical legs of the H, thereby forming the "Karman eddy train." As each eddy detaches itself from the model, a definite lateral push occurs. This effect may be clearly felt by forcing a flat object such as a board, oar, or canoe paddle sidewise through water. The tendency for the object to oscillate laterally, as large eddies alternately trail from the two sides of its leeward face, is very strong.

A significant feature of the phenomenon is that the frequency of the oscillation increases as the velocity of the fluid relative to the object increases. These actions may be investigated conveniently on small models by the apparatus shown in Fig. 2. If the H-beam model is pivoted at AA, lever C removed, rubber bands inserted at EE (simulating the elastic effect of the stiffening girders in an actual bridge) and the fan started and slowly speeded up, the following things are observed: At low wind velocities the model remains motionless or only slightly trembling, but at a certain critical velocity, dependent on the tightness of the rubber bands, the model suddenly goes into violent torsional oscillations. (Actually there is a slight range at the lower end of which a considerable vibration started from an external source will damp itself out, and at the upper end of which the tiniest vibration started from an external source will quickly enlarge to a violent oscillation.) It is evident that at low wind velocities the natural frequency of the eddy train is less than the free-vibration frequency of the elastically restrained model, so that motions of the model are slight and irregular, but as the wind velocity increases a time arrives when these two frequencies become identical, thereby producing a resonance which causes the oscillations to increase enormously.

Cause of vertical oscillations

In the apparatus of Fig. 2 vertical oscillations of the H-beam model may be produced by attaching another light wooden lever similar to C on the far side of the model, pivoting both levers by needles on supports at GG,

removing all other supports and elastic restraints, and inserting rubber bands at FF. This permits the model to oscillate up and down in a motion of translation with only a slight angular component. If the fan is started and slowly speeded up the following action is observed. At low wind velocities the model remains motionless or only slightly trembling, but at a certain velocity, depending on the tightness of the rubber bands, the model suddenly goes into vertical oscillations which increase rapidly until a considerable amplitude is reached and then die out again, this cycle being repeated over and over.

The explanation of this intermittent motion lies in the action of the windward girder in blanketing the wind away from the leeward girder. When the vertical velocity becomes sufficient to permit undisturbed wind filaments to strike the leeward girder, as indicated in Fig. 4, large new eddies are created and new forces are introduced which reverse the sign of the coefficient of lift and quickly damp out the motion. The first occurrence of considerable vertical oscillations is a resonance effect caused by coincidence of the frequency of the eddy train with the natural frequency of the elastically restrained model.

How resonance builds up

The behavior of a suspension bridge with plate girder stiffeners during a gradually increasing wind normal to the structure may now be explained as follows: No motion other than slight trembling occurs until the wind attains a critical velocity where the frequency of the Karman eddy train becomes equal to the lowest possible natural vibration frequency of the structure. In the case here under consideration, where the cables are considered inextensible, the towers rigid and the stiffening girders hinged at the towers, the lowest possible vibration frequency is that of vertical undulations in two loops, the numerical value of this being given by Eq. 3, with $n = 2$. Vibrations of this nature build up rapidly as wind attains its critical value, but do not increase indefinitely, because damping effects occur at the middles of the loops where the greater vertical velocities permit portions of the leeward girder to be exposed to filaments of undisturbed wind.

As the wind increases until the frequency of the eddy train tends to coincide more naturally with the next higher vibration frequency of the structure—in this case vertical undulation in three loops—there will be a shift to this type of oscillation. In the case of the Tacoma Narrows Bridge, motion pictures of the vertical undulations indicate that this process of subdivision of loops had continued until several loops were present. Finally, if the wind increases sufficiently, a point is reached where the frequency of the eddy train coincides

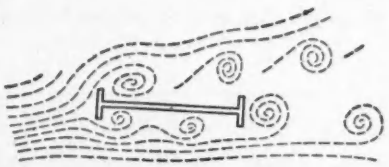


Fig. 4. Karman eddy train formed when a model is placed in a moving fluid. The eddies impart a lateral push to the model as they leave it.

most naturally with the lowest possible frequency of torsional oscillation, that of two loops, the numerical value being given by Eq. 4 with $n = 2$. When this resonance is once established torsional oscillations of great magnitude are quickly built up and continue to increase until the structure is destroyed, or until the values of maximum θ become so large that the law of motion is profoundly modified. The damping factor which limits the amplitude of vertical undulations does not operate in the case of torsional oscillations.

From the standpoint of minimizing the undesirable effects produced by the generation of the Karman eddy train, it is evident that streamlining the windward faces of the stiffening girders of a suspension bridge would be much less effective than streamlining their leeward faces. On page 677 of *Engineering News-Record* for Nov. 21, 1940, is shown a detail of fairing vane, design D, which was proposed for installation on the outward faces of the stiffening girders of the Tacoma Narrows Bridge, for the purpose of reducing the vertical undulations of the roadway. Experiments by the writer with the apparatus of Fig. 3 indicate that neither the vertical nor the torsional oscillations of the small H-beam model are greatly affected by the installation of fairing vanes simulating design D. Installation of the vanes causes the vertical undulations to start at slightly higher and torsional oscillations at slightly lower wind velocities. From the standpoint of preventing the formation of undesirable eddy trains it is obvious that open stiffening trusses are far superior to plate girders, because the truss members do not offer large areas normal to the wind, behind which major eddies can accumulate.

Model studies valuable

For the technical study of aerodynamic phenomenon no other method of investigation is as satisfactory as the use of models. In the case of suspension bridges, two methods of investigation are available, both of which should be utilized by the designers of important structures. The first consists of wind tunnel tests on large-scale and precisely built models of sections of the suspended system. Such tests should include not only determinations of the coefficients of drag, lift, and torque, but also determinations of the eddy train frequency. The latter are obtained by pivoting the models to permit (a) torsional and (b) vertical translational motion, applying suitable elastic restraints and determining the critical wind velocities required to produce resonance. Application of this method requires a mathematical computation of the various free-vibration periods of the structure.

The second method of investigation consists of tests of models simulating the entire structure, subject to actual wind delivered by a fan through a long horizontal slot or nozzle running the entire length of the model and blowing against the floor system. If desired, separate nozzles impinging on the cables and on the floor system may be used. Equations 1 and 2 contain the complete information requisite for the design of such models, the essential relationship being $W = LV^2$ and $EI = WL^3$, where L is the linear scale (ratio of any dimension of model to corresponding dimension of prototype), V the wind velocity scale, EI the girder stiffness scale, and W the scale of weight per linear foot. These requirements are easily met by ordinary materials and moderate fan capacities. As in similar model studies involving turbulent flow, where the same fluid is used in model and prototype, the impossibility of satisfying the Reynolds number requirements does not prevent the attainment of results that are capable of significant and practical interpretation.

Boston-Washington Superhighway

***Contents in Brief**—Plans for a superhighway from Boston to Washington have been under consideration since the Public Roads Administration made its report on "Toll Roads and Free Roads" in 1939. They have now been carried to the point of laying down a tentative route and making estimates of the cost of such a highway. The length is put at 405 miles and the cost at $253,000,000. Estimates are based on building as many as twelve lanes in regions of dense traffic.*

A TOLL SUPERHIGHWAY from Boston to Washington was the only road of that character found by the Public Roads Administration to have any possibility of being economically sound when the PRA made its report on "Toll Roads and Free Roads" to Congress in April, 1939. That report said, "If, as an actual test of the feasibility of a limited mileage of toll road, it is the desire of Congress to make provisions for the construction of a section of highway of substantial length upon which there is a reasonable prospect of the recovery of the cost through tolls, it is recommended that such provision be made applicable to a section of highway, properly located, and extended from an appropriate point near Washington, D. C., to an appropriate point near Boston, Mass."

That recommendation was advanced unofficially in December, 1939, when representatives of the eight North Atlantic States directly concerned with such a highway met with representatives of the Public Roads Administration and set up a committee, headed by E. Donald Sterner, commissioner, New Jersey State Highway Department, to continue the studies begun by the Public Roads Administration. Subsequently, a tentative location for a superhighway from Boston to the District of Columbia was selected and estimates of the cost within each state were prepared. Details of these estimates were reported by Mr. Sterner at the recent meetings of the American Road Builders Association and the Association of Highway Officials of the North Atlantic States.

The route selected for the highway runs directly through the large industrial centers. They were not bypassed because traffic surveys show that the great bulk of the traffic is short-haul, moving from one industrial center to the next.

Proposed route for a superhighway from Boston to Washington. For this study a location passing through the large cities was selected.

The estimates were based on a 12-lane highway in the most heavily congested areas, six lanes of high-speed traffic, and six for the slower traffic. Elevated roads or viaducts will be required at many points to separate the highway from all intercepting roads.

Massachusetts put forward two routes, one, 32.3 miles in length and estimated to cost $6,100,000, used existing highways where they were considered adequate, and the other route, 35.6 miles long and costing $11,500,000, was laid out as a new highway. The state is handicapped by not having a limited-access law that will keep such a highway free from encroachment.

As Connecticut favored a location that did not bring the proposed road into Rhode Island, no item for Rhode Island was included. Connecticut favored a route 122 miles long cutting diagonally across the state in preference to one following close to the present highway along the seacoast. This highway is estimated to cost $60,000,000.

Twenty-one miles of highway through Westchester County, N. Y., and New York City to connections with the George Washington Bridge are estimated to cost $26,000,000, or more than $1,000,000 a mile. Similar high costs will be required to carry the highway through the densely populated industrial areas of New Jersey. The 91.8 miles called for in that state are estimated to cost $73,000,000.

From the George Washington Bridge, the route south into New Jersey would follow a location already officially set up as Route No. 100 which runs southerly past the western terminals of the Lincoln Tunnel and the Holland Tunnel to Bayonne, from which point it would cross Newark Bay on a highlevel bridge and would continue south to Camden on a new right-of-way.

The Philadelphia-Camden Bridge was selected as the point for crossing the Delaware River, bringing the highway directly into Philadelphia.

ESTIMATED COST OF SUPERHIGHWAY

State	Estimated Cost	Mileage
Massachusetts	$11,500,000	35.6
Connecticut	60,000,000	122.0
New York	26,000,000	21.0
New Jersey	73,000,000	91.8
Pennsylvania	24,500,000	20.4
Delaware	10,000,000	24.0
Maryland	48,000,000	90.0
	$253,000,000	404.8

From the bridge the highway would be carried through Philadelphia by way of Delaware, Oregon and Penrose avenues, thence south to the Delaware state line, 20.4 miles at an estimated cost of $24,500,000.

The route across Delaware will be 24 miles long and construction will cost $10,000,000.

Three routes across Maryland were explored, all passing through Baltimore. The cost of each was about the same. The route selected is 90 miles long and will cost $48,000,000.

No route from the District of Columbia line into Washington has been selected by the district officials. hence no cost figures for that part of the route are included in the total.

Painting Golden Gate Cables From New Type Scaffolds

LIGHT-WEIGHT SCAFFOLDS for painters working on the main cables of the Golden Gate Bridge have greatly increased the safety and decreased the cost of paint maintenance on this part of the structure. Prior to development of special scaffolds, the under side of the main cables had to be painted by workers on a plank slung from ropes—a precarious and inefficient method. With the new equipment, a crew of four painters in 7 hr. has painted 725 lin. ft. of the 36-in. cable including castings, the two 1-in. hand ropes and the two ⅝-in. messenger cables. Costs are greatly reduced as compared to the old program, and the 4-man crew can now average about 600 lin. ft. of main cable per day, almost double the previous rate.

Paint maintenance on this bridge naturally divides itself into two classes: cables and structural steel. In painting the structural steel, of which there is some 78,600 tons, the ultimate objective is so to adjust crew and painting schedule that the same men can be employed continuously, returning to the starting point as soon as one complete operation has been finished. (A difficulty in this program, as yet not overcome, is the necessity for seasonal layoff during the rainy winter months). Specially designed scaffolds for painting the stiffening trusses were described in *Engineering News-Record*, Apr. 25, 1940, p. 582.

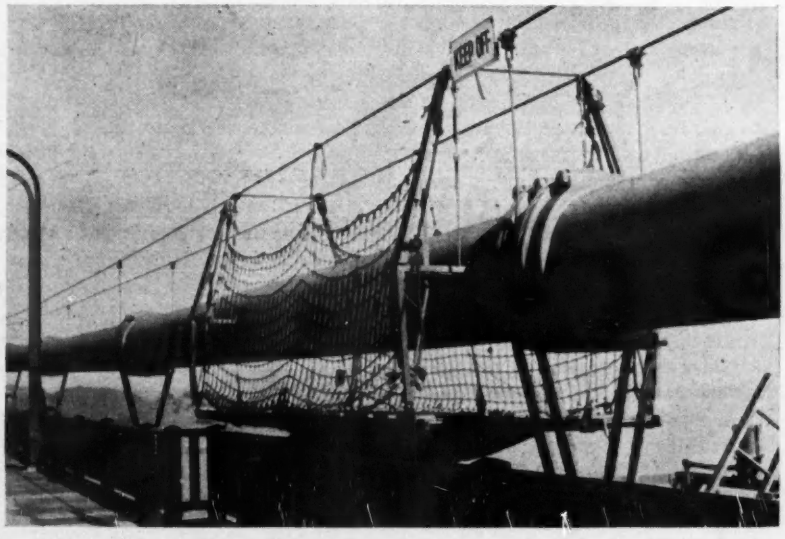
In contrast with structural steel, main and suspender cables can be given the necessary three coats of paint by two 4-man crews in about 2½ months. The expectation is that this three-coat treatment will last five to six years.

The first painting of the bridge cables was part of the construction operation, completed in 1937. The first repainting, now under way, begins with a wire brushing to remove any loose paint, rust, etc., followed by what is called a "spot" coat—a misnomer because it involves painting most of the area, and the quantity of paint required often exceeds that used in the second coat. With the paint formula now used, the second coat can be put on 48 hr. after the first coat; the third coat can be applied 4 days after the second coat. The combination is:

1st coat	Iron oxide modified red lead primer	24 lb. per gal.
2nd coat	Red lead and oil	28 lb. per gal.
3rd coat	Oil-modified, synthetic, international orange (for color)	20 lb. per gal.

Cost of the painting, based on average progress per crew of almost 600 lin. ft. per day, is 21.2c. for the first, and about 15c. each for second and third coats, per linear foot of main cable. This cost includes paint, labor and overhead. The "overhead" provides for a laborer who mixes paint, fills buckets, etc., for riggers to take out the scaffolds and set them in place (the painters themselves move the scaffolds) and, finally, for supervision by a foreman.

Two of the new light-weight scaffolds were built in the bridge maintenance shop. The working platforms are ordinary painter ladders, one on either side of the main cable, carrying a walk board with cleats which are needed on the steeper slopes, ranging up to 27 deg. near the towers. The ladders are supported by four metal hangers, two on each side, slung from the 1-in. hand rope above the main cable. The metal frame is largely aluminum, although cables, plates and bolts are steel. Since the main hangers are connected to the walkway by pins, the working platform remains parallel to the cable on the



Light weight scaffold at midspan. From this rig painters work safely all around the cable, and obstructions are passed easily.

slopes. Between the two working platforms is a canvas apron for safety and to prevent drops of paint from going down on to the bridge deck. A safety net on either side consists of a ½-in. rope with 6-in. mesh.

The canvas apron can be unhooked along one edge for its entire length and all other connections between the two working scaffolds and their supporting hangers are attached by spring snaps at either end, thus permitting the two halves of the scaffold to be separated and swung outward to enable them to pass around suspended cables and other obstructions.

The scaffolds were designed by Russell G. Cone, engineer, Golden Gate Bridge and Highway District.

Can the Inspector Be an "Umpire"?

DeGraffenreid DuPuy

Materials Engineer
Public Roads Administration, Panama Canal Zone

LET A DIFFICULT PROBLEM in design, or a simple one in plane surveying present itself, and engineers all over the country will take up their slide rules and not lay them aside until a formula, foolproof and workable, is made available to the profession at large. Strangely enough, however, these same engineers have ignored a problem which rests squarely on their own doorstep—that of inspection.

The owner provides the inspector as a necessary evil and thereafter hopes he won't have to think further about inspection. The fact that his faith almost always comes to naught and troubles ramify in all directions from the inspector deters him not a whit when the same problem arises again. If the owner considers the importance of inspection in relation to the importance of good workmanship and keeps in mind the fact that he is paying for the former in order to guarantee the latter, the purpose of inspection will be more appreciated, and the problem of how it can be made to serve that purpose best will be more easily solved.

Inspection is not exact

Inspection, which deals with the abstract, is properly a function of the engineering department, but cannot be expected to discharge its obligations fully, so long as it is regarded as a festering appendage of a department which deals more particularly with the mathematically exact parts of the work. To be in a position to cooperate with all departments the inspection unit must be independent of them insofar as the administration of its internal affairs is concerned.

During recent years some improvements in inspection methods and practices have been made. These, however, have not kept pace with the profession of which inspection is an integral part, and on which it depends for good materials and workmanship. The blame for this regrettable fact must be divided into three unequal parts, with the largest share going to the owners because they have been in the best position to improve the present system, but have made little effort to do so. The inspectors themselves deserve second place, because they have failed to make the most of such opportunities as existed to raise the standards of their profession. The contractors get off with the smallest share because they, as the visiting team, have never been in a position to protest too strongly against the ground rules set up by the home team.

Authority not defined

Many owners are reluctant to limit or define the inspector's authority and even more reluctant to discuss it with the contractor, who, in company with the inspector, is left to flounder in a morass of uncertainty and doubt while the owner straddles the fence of indecision. This is, in a sense, understandable, since the purpose for which inspection is required is in itself ambiguous and difficult to define by set rules and regulations. Either too much or too little authority in the hands of the unseasoned inspector has taught the owner the evils of these extremes, and failing the blessing of an inspector to whom he can delegate authority without fear of having it abused, he leaves the whole issue obscured, with the result that when friction arises, the inspector often emerges as the scapegoat.

The first consideration in the organization of an inspection department is a capable man to head it. The type and scope of the work and the speed with which it is to be prosecuted will, of course, determine the number and kind (concrete, masonry, steel, etc.) of inspectors required. These matters should be left to the chief inspector, who should be retained far enough in advance of actual construction to allow time for the employment of inspectors on a selective basis and time to work out the details of the organization and to familiarize himself thoroughly with the plans, specifications and work schedules.

In this work, where psychology is much more valuable than calculus, a highly developed sense of justice, fair play, and humor are as indispensable as the ability to organize, manage and direct. To know when to enforce the specification to the last crossing of the last 't' and when to take a walk, the chief inspector must not only be thoroughly conversant with the specification as worded but with the underlying engineering principles involved.

Baseball has its umpire

The inspector's job and that of the baseball umpire are not so vastly different in purposes. The umpire, in theory at least, is fair to both sides; so, too, the inspector who, unblinded by any misconceived idea of loyalty, possesses the same sense of fair play the umpire is assumed to possess. In baseball, of course, payment of the umpire's salary is proportioned equally between the contesting teams, with all three parties in agreement on the rules by which the game is to be played before they take the field. For the national pastime this is a highly satisfactory arrangement, and although it is not suggested as a model in its entirety for the construction industry, it is clear that an understanding at the outset between owner and contractor, for the benefit of the inspector, is practicable, and that a general outline of his responsibility and authority is indispensable to efficiency.

From Mule-Cart Water Delivery To a Monumental Storage Tank

NOVEL IN DESIGN and attractive in appearance is a reinforced concrete water tank pedestal recently constructed at Roma, Texas. The tower is a part of a complete water system, including intake, purification, and distribution facilities, which this community has installed with the aid of the Works Projects Administration. Prior to the completion of this system this southwestern town depended on mule cart deliveries for its water, which was drawn from the Rio Grande.

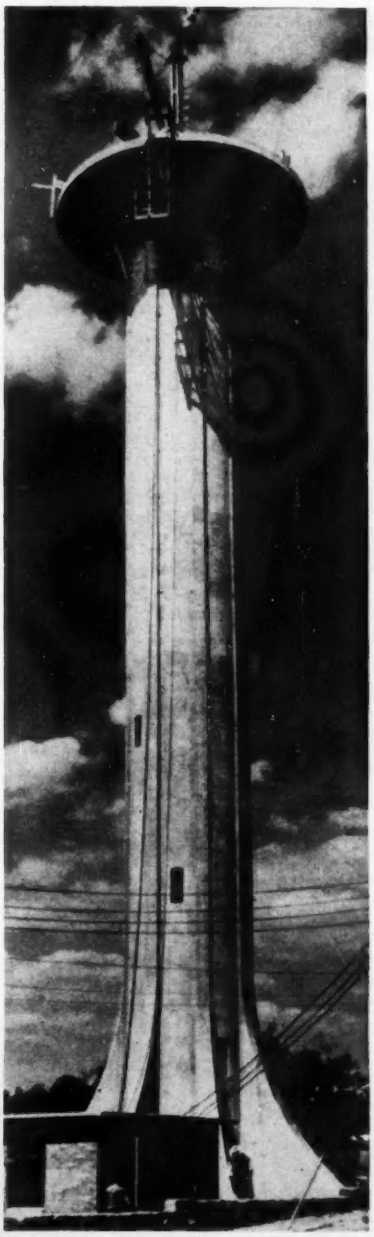
The concrete shaft, or pedestal, upon which a 60,000-gal. steel storage tank rests is the outstanding feature of the plant. This tower is the first structure to be built from the designs of J. W. Beretta, Engineers, Inc., San Antonio, Tex. Constructed of reinforced concrete, it is 100 ft. from the base to the storage tank platform. The hollow cylindrical tower with a diameter of 11 ft. has walls which are 10 in. thick.

The use of external reinforcing ribs of concrete, which extend for the whole height of the pedestal and terminate in parabolic curves at the base and at the upper platform slab, not only provides additional strength but adds to the appearance of the structure as well.

Most of the construction work on the pedestal was carried on from inside the tower. Forms for the concrete were held in place by special bolts so arranged that the bolts holding the top part of the forms for one pour could be utilized to hold the bottom part of the form for the next lift.

Intake works for Roma's water supply, installed in the Rio Grande, consist of an intake pipe, cylindrical well and pump pit. The purification plant includes an aerator, chemical feed house, mixing basin, rapid sand filter, clear water well, and a pumphouse. The pump is designed to deliver 250 gpm. to the elevated storage tank.

This undertaking called for expenditures of $111,000, of which about $66,000 came from WPA funds and $44,000 was contributed by the sponsor.



The hollow concrete pedestal, which will support a 60,000-gal. steel water tank, gains additional strength and beauty by the use of external reinforcing ribs.

Supplanted by the new water supply facilities in Roma, this vendor of water at 15 cents a barrel now has only a few customers in unpiped sections of the town.

From Field and Office

Working problems and time-saving methods for engineers and contractors

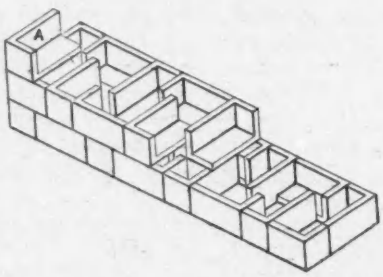
Hot Asphalt Cutter For Wide Pavements

In placing the hot asphalt surfacing for wide runways at the U.S. Naval Air Station near Corpus Christi, Tex., a clean-cut joint was desired between the strips laid by successive passes of the spreader. The illustrated cutter, devised by the writer and built by mechanics on the job, is proving very successful for this work. It consists of a flanged roller mounted on the left side of the frame of a tandem road roller. The flange, which is the cutter, is 3 in. greater in diameter than the roller, permitting a cutting depth of 1½ in., or the thickness of the hot-mix surface. The roller is carried in a bridle pinned to the frame with a free pin. Pressure on the cutter is applied by hand through a long lever arm, and when not in use this arm is chained in a raised position to keep the cutter well above ground level.

Use of the cutter minimizes the effect of the cold joint between adjacent surface strips. The device is regarded as more economical and satisfactory than the conventional heavy greased rope rolled into the hot materials to form the joint.—Lt. H. L. Haworth, CEC, U.S.N.R., *U. S. Naval Air Station, Corpus Christi, Tex.*

Wall Block for Fast Work

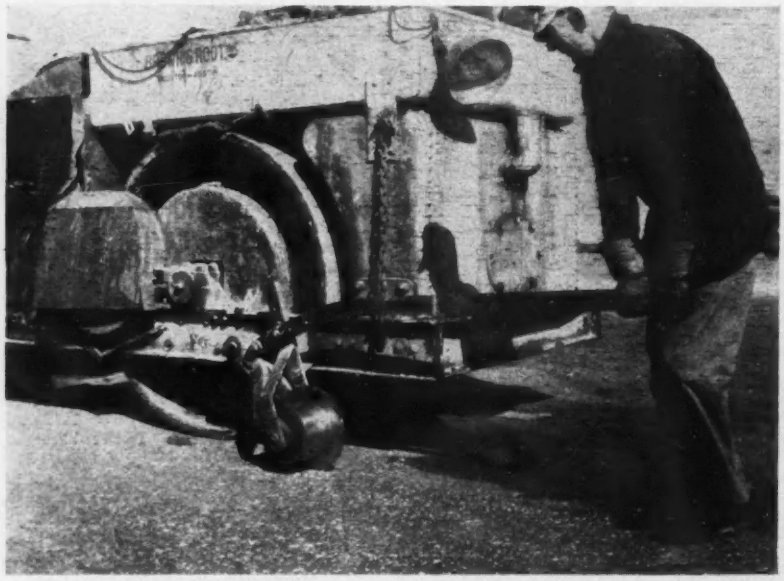
A concrete wall block developed for defense construction by British manufacturers offers several advantages for civil construction, particularly that of a semi-permanent type. The shape of the precast unit is shown at *A* on the sketch, which also shows the manner of laying up the units into wall. As used the blocks are laid up for protection in place of sandbags or as walls for depressed shelters from aerial bombing attack. No mortar is used but as the wall is built up the compartments are filled with sand, gravel or soil. Considerable strength is had by the bond of the header blocks partly through the wall. The standard block is 18x9x9 in. and it weighs about 50 lb. The advantages, as compared with regular four-sided blocks, are less weight to transport and handle, a shape that permits close nesting for transport, the use of less cement and mortarless construction by semi-skilled labor. This account is condensed from an article in *The Surveyor*, July 20, 1940.



Sand-filled wall of three-sided concrete blocks laid dry.

Floating Bridge Lights

Because of a variation of about 40 ft. between normal and flood stage of the Alabama River, adjustment of elevation of the four navigation lights on the Edmund Pettus Bridge at Selma, Ala., is necessary. In order to do away with the expense of a caretaker, the lights have been attached



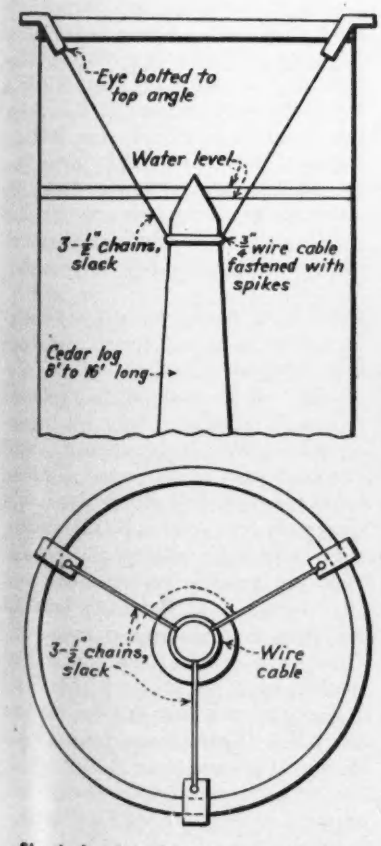
Home-made cutter attached to tandem roller cuts joint in hot-mix surfacing on wide runway. When not in use the cutter is held clear by chaining the lever arm to a bracket on the roller.

Hollow steel drum inside Selma, Ala., bridge provides floating navigation light.

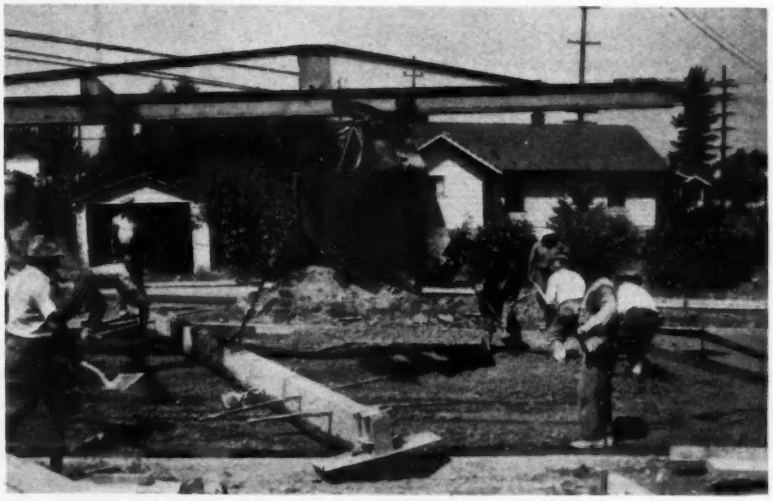
to large hollow steel drums floating freely inside of the hollow bridge piers so that the lights, moving up and down with the drum, are always at a constant distance above the river level.—SIGMUND SAMETH, *New York City.*

Ice Breaker for Surge Tanks

Ice prevention in surge tanks is cheaply and effectively accomplished by the device illustrated by the accompanying sketch. The water in the tank is in motion when the turbine is operating which keeps the cedar log moving and prevents the formation of ice. At other times the water is moving due to temperature changes. Without the log, in a sudden cold spell, the water would freeze and put a heavy pressure against the sides of the tank, but with the log in place, even if the water is quiet, the ice tends to climb the pointed top, breaking the force of the ice pressure due to expansion. The top of the pointed log should be about 6 in. above the surface when the water is reasonably still.—C. E. NIGHTINGALE, *Old Greenwich, Conn.*



Simple ice breaker for surge tanks.



Mechanically operated drag saves hand labor and reduces cost of paving for city of Seattle.

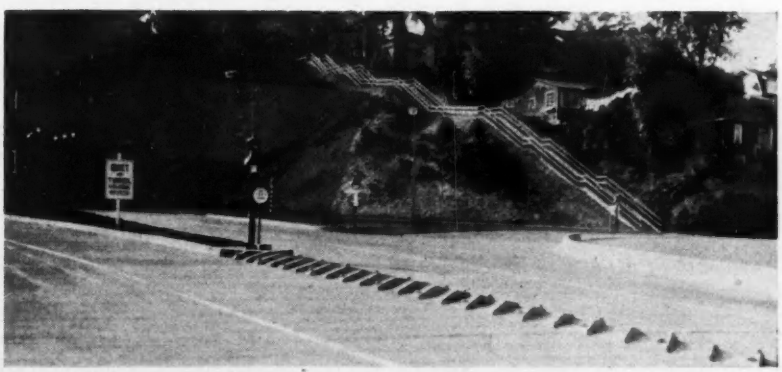
Improving Paving Work

Under City Engineer Chas. Wartelle, the cost of paving operations in the city of Seattle has materially decreased, and with the use of a twin-batch paver the quality has been raised.

With the increased output of the twin batch, we found that our main difficulty was the proper dragging of the subgrade. We induced the contractors, the Northwest Construction Co., to weld an eye on the back of the bucket and attach a 5-ft. chain by means of an eyebolt to the center of the drag.

Now, instead of using extra men to pack the drag back, or pinch-baring it back with the subgrade crew, the slow and laborious process is avoided by hooking the chain to the eye of the bucket and allowing the operator to kick the drag back in one-two-three time without any holdup of his mixing and placing operations.

The bucket eye is a 4x4x$\frac{5}{8}$-in. piece of steel with a 1½-in. hole punched out of the center. Its edge is welded to the mixer side of the bucket 1½ ft. below the top.—C. M. MILLER, *Junior Field Engineer, City Engineer's Office, Seattle, Wash.*



Warning Barriers for Traffic Lanes

Warning to motorists who get out of traffic lanes in approaching or leaving the Lake Washington floating bridge is given by cast-in-place concrete ridges in the pavement in front of separation strips. Before the paving was poured, forms were set up for these concrete ridges, thus making it easier to get a uniform height increment toward the 6-in. curb and also the desirable uniform slope. The slope is with the direction of traffic or tends to turn an encroaching car away from the obstruction.

Reflector buttons on every alternate ridge give night visibility.

Notes on Sewage Disposal

A monthly summary of current developments conducted by Willem Rudolfs

SEWER RENTAL HISTORY — Early as was Fayetteville, N. C., in charging for the use of sewers in 1910 (*ENR*, Feb. 27, 1941, p. 71), Brockton preceded it by fifteen years. The Brockton plan was worked out by F. Herbert Snow, then city engineer, in a notable report on financing the new sewerage and sewage-treatment system for Brockton (see *Engineering News*, 1894, Vol. II, pp. 51 and 53 for lengthy abstract and for editorial comment). Snow advised that half of the first cost and of maintenance be met by a charge on users of the sewers, a fourth by assessments on abutting property, vacant or otherwise, and the remainder, about one-fourth, by general tax levy. The rental was to be based on the volume of sewage from each property. In 1896, Marlborough, Mass., put a similar plan into effect.

Abroad, Paris adopted a charge for the use of its sewers in 1894, along with its *tout l'égout* plan—house connections were prohibited up to that time.

Users of sewers in Atlantic City, N. J., have paid sewer rentals since the sewerage system was built by a private company in 1885.

Ohio has been credited as the first state to authorize its municipalities to charge for the use of its sewers—in 1923. But thirty years earlier it was authorized by Massachusetts (*Sect. 1, Chap. 245*, Mass. Acts of 1892)—*Contributed by* M. N. BAKER.

TYPHOID IN SLUDGE — Typhoid bacteria present or added to sewage sludge disappear usually within 2 to 4 weeks when kept under laboratory conditions. Examinations of well-digested sludge obtained from separate sludge digesters fail ordinarily to disclose the presence of these organisms. Mom and Schaeffer (*Mededeelingen Dienst Volksgezondheid in Netherlands Indie*, vol. 29, 1940) call attention to the finding of considerable numbers of typhoid bacteria in digested Imhoff-tank sludge. They find that small changes in the character of the sludge have a considerable effect on the death rate of the organisms. For instance, if the sludge is sterilized the organisms remain much longer in the sludge. This is possibly due to the absence of antagonistic substances or the greater availability of the materials. The fact remains that the wet sludge under certain conditions contains virile organisms.

There appears to be a close connection between the solid sludge particles and the presence of typhoid bacteria in the sense that the sludge particles afford protection against outside influences; the more compact the structure of the sludge particles the greater the protection. About 80 percent of the typhoid bacteria present in the sewage settles with the sludge.

Drying of the sludge on sand beds appears to kill the bacteria readily. No typhoid bacteria could be isolated from dried sludge, although considerable numbers were present in the wet material.

EFFECT OF SLUDGE ON SEA WATER—Large quantities of settled and partially decomposed sludge are discharged at sea by New York City, the Passaic Valley Sewerage Commission and the Elizabeth Joint Meeting. The discharge points are designated and closely adhered to by the various authorities. The possibility of creating nuisances and contamination was investigated by representatives who made a survey over a period of a week. Daily, a series of samples were taken before, during and after sludge dumping. The results were very illuminating as shown by the following averages:

	Sea Water Alone	Sea Water and Sludge
Suspended solids	5. ppm.	5.02 ppm.
Dissolved Oxygen	9.5 ppm.	9.5 ppm.
B.O.D.	0.7 ppm.	0.9 ppm.
Total bacteria	12 per c.c.	12 per c.c.

Upon discharge the sludge sinks rapidly and leaves practically no trace in the dumping area, so that the possibility of quantities of floating material or appreciable bacterial contamination may be considered absent. The results are in conformity with studies previously made abroad in England and Holland.

KILLING POLIO VIRUS— Reported some time ago was the fact that chlorine (chloramine) in city water in a concentration of 0.5 ppm. did not inactivate the virus of poliomyelitis in 1.5 hr. but required 4 hr. at which time the chlorine concentration had dropped to 0.35 ppm. Kempf, Pierce and Soule (*Jour. Bacteriology*, 41, Jan. 1941) now report the effect of chlorine, using calcium and sodium hypochlorites as sources of the chlorine. A solution of calcium hypochlorite in tap water containing 1 ppm. of chlorine and acting for 25 min. had no effect on the virus. At the end of 4 hr. the chlorine content was down to 0.2 ppm.; injection of the virus suspension in monkeys produced quadriplegia (paralysis). Essentially the same results were obtained with sodium hypochlorite, but 1.5 ppm. chlorine inactivated the virus in 20 min. A concentration of 0.55 ppm. chlorine in river water inactivated the virus in 1 hr. while a residual concentration of 0.2 ppm. for the same length of time had no apparent effect. Keeping in mind that the virus remains active in river water for some time, it may be that swimming in polluted streams is more dangerous than generally expected.

TREATMENT PLANT EFFICIENCY—Examination of plant records discloses that extreme variations in the suspended solids load in an influent to a plain subsidence tank are reflected only mildly in the effluent. Still less, of course, is the variation where sewage is especially prepared for subsidence by flocculation. B.O.D. values, only moderately affected by subsidence, are nevertheless reduced more than variation in flow and load of raw sewage would appear to permit. These were some of the conclusions reached by A. M. Rawn, acting chief engineer of the Los Angeles County Sanitation District, who reported his studies of sewage flows and composition at a recent meeting of the Federation of Sewage Works Associations.

Data indicate that as a rule sewage containing 400 ppm of suspended solids will lose as many pounds of solids in 30 minutes in a well-designed sedimentation tank as sewage containing 100 ppm will lose in 2½ hours. Stated in another fashion, sewage containing 400 ppm of suspended solids will drop over half thereof in an hour, while that containing 100 ppm will drop only one-fourth in the same length of time.

It is also a fact that velocities in sedimentation tanks, and consequently through-put quantities, may vary widely from those calculated to be the optimum and still permit the process to yield excellent removals. By virtue of this, such treatment as follows primary sedimentation does not have to absorb the shocks of wide changes in quality, being cushioned therefrom by the primary sedimentation process. There is, fortunately, a definite elasticity in the oxidizing capacity of activated sludge and in trickling filters, which accounts for their ability to absorb short overloads without serious impairment of the final effluent.

OIL AND ACTIVATED SLUDGE — Vegetable and mineral oil which may be present in activated sludge plants conceivably may cause retardation of the process in addition to promoting troubles with foam formation. The amount of experimental work conducted along these lines is very limited and results obtained by Watanobe (*Mitteilungen Medizinischen Akademie Kioto*, Japan, 30, 862, 1940) are of interest in this respect.

The oils in sewage originate usually from vegetable and animal sources and any mineral oil discharged by garages or industries. Destruction of vegetable oil added up to one per cent was found to be considerably slower than decomposition of other organic material, but the presence of oil did not affect the biological activities of the sludge. More vigorous aeration was necessary. The optimum conditions were around the neutral point, although slightly acid and slightly alkaline conditions made no great difference.

The problem of mineral oil is of considerable interest. Experience has shown that the oil will gradually disappear on aeration, but that considerable portions of the oil adhere to the floc, become curdly and interfere with dewatering.

POLIOMYELITIS AND SEWAGE — During two epidemics of poliomyelitis the causative virus was detected in sewage. As the epidemics subsided negative results were obtained from samples collected at the same places. Trask and Paul (*American Journal of Public Health*, March, 1941) have extended their studies. They state that the positive results with the virus are "an index of the large amounts of virus which sewage may contain and they point to our grossly contaminated waterways as a natural source of virus."

However, how can the magnitude of this virus distribution be reconciled with the relative ineffectiveness of the virus or the spasmodic epidemics? If the virus present in polluted streams were readily infective, more epidemics should result. The authors suggest the possibility "that another cycle, with passage through a non-human host, for example, is necessary before the virus could become effective for man again."

In polluted waterways there is a great natural source of virus to which many forms of life are exposed. There are many methods of transmitting poliomyelitis in monkey and man. The possible importance of polluted water rests on the intestinal features of poliomyelitis. However, the incidence of the disease is highest in rural districts, when children, vegetation, domestic animals, birds and insects, open water and freshly broken ground may be present. The authors conclude "that most epidemics are not water-borne in the usual enteric sense, but polluted water may be important in some other way as yet undisclosed."

PATHOGENIC BACTERIA obtained from sewage and inoculated into monkeys resulted in development of tuberculosis of the ormentum. The animals were inoculated intra-abdominally so that it is likely that viatec tubercle bacilli were present in the sewage from which samples were taken.

Simple Scaffold Supports Facilitate Glass Roof Cleaning

GLASS ROOFS on sludge bed enclosures can easily be cleaned of dust deposits with the aid of a scaffolding device such as used at the Meadville, Pa., sewage treatment plant and illustrated in the accompanying photographs taken by an *ENR* editor.

The scaffold planks are attached to flat band iron supports, which are formed in the shape of a right triangle. Keyhole shaped openings in the supports are designed to fit into lugs permanently attached to the roof frame. The lugs are simply ¼-in. round head bolts, which protrude about ¾ in. above the frame.

With three scaffold planks equipped with supports and a small step-ladder, it is possible to reach any part of the glass roof for cleaning or making repairs. At Meadville, where Roy Phillips, city engineer, is in charge of treatment plant operation, the glass-inclosed sludge beds are cleaned frequently to obtain the maximum effect of sunlight as well as to present a good example of municipal "housekeeping."

Non-Corrosive Paint for Steel Work

***Contents in Brief**—Experience on the control gates of 33 Mississippi River dams reviewed in the light of eight years' operating records. Conclusions indicate protective program should include: (1) removal of scale, (2) inhibitive treatment with phosphoric acid, and (3) at least three coats of pigmented tung-oil varnish.*

INEFFECTIVE PAINT PROTECTION on some of the steel controlling gates on dams of the Upper Mississippi and Illinois rivers led to research for some coating that would be effective, durable and economical. The conditions and results were reviewed in a lecture at the Chicago Museum of Science and Industry by Charles H. Ellaby, senior civil engineer in the U. S. Engineer Office at St. Louis.

With 33 dams on the two rivers, the average area of steel surface for each dam is 250,000 sq.ft. Acting as barriers to the flow, the upstream side is submerged, while the downstream side is generally exposed to the air. Periodically, the gates are raised above the water, so that both sides are exposed to the air for varying periods, and this condition of alternate wetting and drying is severe on paint coatings. Originally, the practice was to use a lead pigment in a linseed-oil vehicle but soon after the first dam was completed rapid failure of the paint was indicated, and after relatively short service there was serious corrosion.

Research pointed toward paints with synthetic resin vehicle and narrowed down to the 100-percent phenol-formaldehyde resin with China wood-oil as the vehicle. Various types of paints were applied to 30-in. steel disks, which were exposed to weekly cycles of alternate wetting and drying for seven months. The superior durability of the above coatings appeared after two months of the test.

A severe abrasive condition exists at these gates, due to driftwood churning and revolving at high velocity. This led to a reduction of the tung-oil content of the vehicle from 50 to 40 and finally to 25 gal. of oil per 100 lb. of resin, thus increasing the hardness and durability of the paint.

Having developed the optimum physical properties for the vehicle, attention was given to the pigmentation. It was determined that only zinc-chromate possessed the ability for inhibition of rust, and that the optimum proportion was 60 to 65 percent of the pigment. But while this paint had some merit, very little effective chemical inhibition could be achieved by pigment particles bound in such a highly impervious medium as tung oil. At this stage, Mr. Ellaby states: "Therefore, I began investigation of separately applied films of phosphoric acid, which are true chemical inhibitors by virtue of their reaction with iron to create a non-corrosive iron-phosphate surface on a material, prior to the application of paint. These investigations developed what may be termed almost miraculous results in the prevention of blistering of paint films with resultant corrosion. This inhibitive treatment or wash, since it is largely water, may be readily, quickly and safely applied to sandblasted steel surfaces, and application of paint made immediately after drying."

Concerning resistance to abrasion and the erosive effect of water passing over the surface at high velocity, experiments were made with sand introduced into the film. It was found that the sand could not be mixed with the paint prior to application, but must be embedded in the fresh wet priming coat and covered with two finished coats. The next problem was to secure adhesion between multiple coats of the paints thus devised. It appeared that separation did not occur where the under coat contained aluminum pigment. Such paints had been adopted for finish coats on account of their light weight, pleasing appearance and resistance to the destructive effects of ultra-violet rays on the binding medium of the paint. But when thus used, the finish coats readily separated from all priming coats in underwater service. This peeling caused an unsightly appearance that suggested corrosion, although the priming coat provided ample protection. Finally: "a simple method to secure both the protection of multiple film coating as well as a uniform film color, was to incorporate a leafing aluminum pigment in the priming coat."

Conclusions

Conclusions based on this extensive research are presented by Mr. Ellaby as follows:

"Summing up the results of these past eight years of extensive investigations and tests, it is now my opinion that the most economical, durable and satisfactory protection for steel surfaces that can be achieved by the materials available today for the service in question, has been determined, as indicated in this dissertation. The procedure consists of: (1) complete removal of all mill scale either by acid pickling or sandblasting; (2) inhibitive treatment of newly cleaned surfaces with a phosphoric acid-sodium dichromate solution, and (3) application of at least three coats of a synthetic phenol resinoid tung-oil varnish vehicle paint pigmented to suit the particular condition existing. Through this research, changes have been effected in specifications for the procurement of a coating system which is excellent after two years' service, as compared with the original paints which failed within two or three months."

Capacity of Cement Bins

Contractors and other users of bins for storing bulk cement must make allowance for the bulking effect and the relatively lighter weight per cubic foot of some of the special cements and standard cements which are finely ground. Since the normal capacity rating of bulk cement bins and equipment to handle bulk cement is

(*Continued on p. 74*)

941 CONSTRUCTION COSTS

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*Registered Trade-Mark

WOLMANIZED LUMBER

(*Continued from p. 72*)

usually based on the accepted figure of 94 lb. per cu.ft. for standard portland cement, any bulking for normal fluffing, any excessive reduction in the specific gravity of the material, will reduce the bin capacity below this expected rating.

Bulk cement may be aerated during handling and some of the special cements, particularly those designed for high-early strength and finely ground will tend to bulk more than standard portland. Naturally, a cement of this type or in this condition will occupy more space per pound or per barrel than the material which forms the basis for normal bin design. Measurements have indicated that certain cement in a loose or fluffed condition may not weigh more than 60 lb. per cu.ft.

The planning of installations on construction jobs where bins or conveying equipment is planned for the handling of bulk cement should consider this factor of requirement for added capacity.

• • •

Clarifying Muddy Water

The character of silt in muddy water as a factor in the method of clarification is noted in a paper by F. B. Lasell on the Florence water treatment plant at Omaha, Neb., in the monthly bulletin of the Omaha Metropolitan Utilities District. The turbidity or amount of silt and sand held in suspension in the water of the Missouri River varies greatly. During the winter, with the river frozen over, the turbidity is usually less than 100 ppm., while during the spring and early summer it has been as high as 32,000 ppm. This is not such a baffling problem as it might appear, because generally speaking the light clay that is carried in suspension lends itself readily to treatment. In fact, some of this material is bentonite clay, which is brought down from South Dakota, and is a material frequently used as an aid to coagulation.

The most difficult time for treating the Missouri River water is said to be in the spring, just after the ice breaks up. This is due primarily to the high organic content and to the color resulting from the decaying vegetation of the previous season, as well as the flushing out of numerous small streams and rivers that empty into the Missouri.

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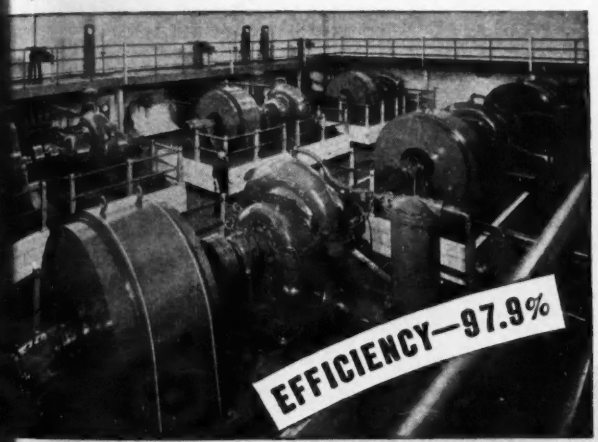

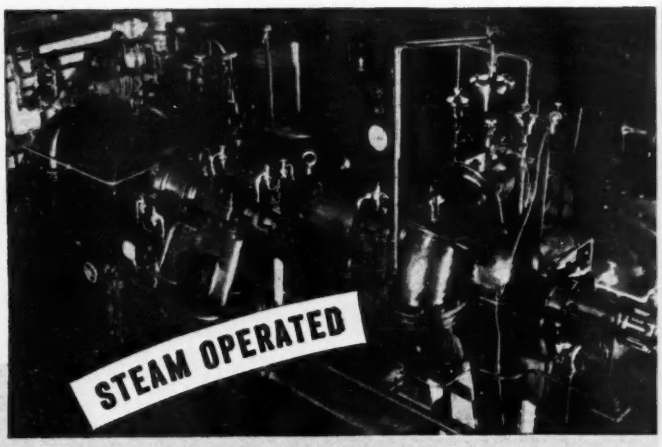

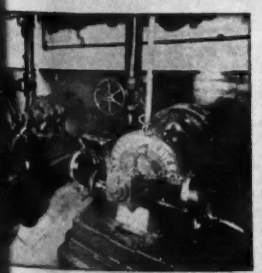

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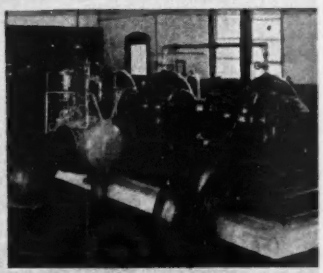


Westinghouse WATERWORKS EQUIPMENT

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

STREAM-CONTROL WORKS
WATER SUPPLY PROJECT, N. Y.

OWNER: Board of Water Supply, City of New York, N. Y., G. J. Gillespie, president.

PROJECT: Construction of stream-control works (Contract 360) for proposed Neversink Dam, consisting of diversion tunnel and cofferdam, excavation of portion of cut-off trench, sinking of two exploratory caissons, pumping of ground water from caissons and nearby deep wells, and construction of all appurtenant structures. Location is ½-mile from village of Neversink, Sullivan County, N. Y. Diversion tunnel to be concrete-lined tunnel in rock, circular, 30-ft. diameter within concrete lining, and approximately 1,500 ft. long. Cofferdam to be of earth and rock embankment with special closure section containing steel sheet piling, approximately 2,000-ft. in length with maximum height of 50-ft. Caissons to be of concrete masonry heavily reinforced with steel, rectangular in horizontal section and 45-ft. long and 12-ft. wide, height about 150-ft.

CONDITIONS: Railroad facilities about 8 miles from site of work, highway passes through Neversink. Contractor to furnish all materials and complete work in 20 months. Wage rates specified are: skilled labor 85c. to $2.25 per hr.; semi-skilled, 70c. to $1.65; and common labor ranges from 75c. to 87½c.

BIDS: Nine bids were opened February 18, 1941, ranging from the contract low of $3,406,895 to the highest bid reported, $4,865,425.

LIST OF BIDDERS:

1. George M. Brewster & Son, Inc., Bogota, N. J. (contract) $3,406,895
2. Shofner, Gordon & Hinman, Los Angeles, Calif. 3,424,600
3. B. Perini & Sons, Inc., Framingham, Mass. 3,491,305
4. Cogan Bros., Inc., and P. J. Carlin Constr. Co., New York, N. Y. 3,695,100
5. Samuel R. Rosoff, Ltd., Kerhonkson, N. Y. 3,699,650
6. Rusciano & Son Corp., Bronx, N. Y. 4,095,950
7. S. A. Healy Co., Inc., White Plains, N. Y. 4,212,250
8. Dravo Corporation, Pittsburgh, Pa. 4,518,525
9. Catskill Constr. Corp., Pleasantville, N. Y. 4,865,425

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Remove buildings	140,000 s. f.	$0.20	$0.10	$0.10
2. Remove soil	130,000 c. y.	.35	.65	.50
3. Earth excav., open cut	700,000 c. y.	.72	.65	1.20
4. Earth excav., caissons from bottom cut-off trench to El. 1200	2,000 c. y.	23.00	15.00	21.00
5. Earth excav., caissons between 1200 and El. 1160	1,650 c. y.	64.00	35.00	28.80
6. Earth excav., caissons, below El. 1160	1,700 c. y.	64.00	40.00	28.80
7. Rock excavation, open cut	180,000 c. y.	2.40	1.90	1.20
8. Rock excavation, caissons	400 c. y.	100.00	60.00	50.00
9. Rolled embankment	400,000 c. y.	.20	.25	.35
10. Refilling and embanking	250,000 c. y.	.09	.15	.10
11. Rock filling and embanking	400,000 c. y.	.10	.15	.20
12. Conc. masonry, open cut	13,000 c. y.	11.70	11.00	10.00
13. Conc. masonry under air pressure	900 c. y.	25.00	35.00	20.00
14. Dry rubble masonry and paving	12,000 c. y.	6.00	5.00	6.00
15. Rubble masonry and paving, mortar	24,000 c. y.	7.00	9.00	8.00
16. Rubble facing in mortar	4,300 c. y.	13.50	22.00	25.00
17. Steel sheet piling	1,200,000 lb.	.08	.06	.05
18. Structural steel	95,000 lb.	.10	.20	.10
19. Steel for reinf. concrete	550,000 lb.	.055	.06	.05
20. Timber and lumber, open cut	100 Mbm.	160.00	120.00	125.00
21. Rock excavation, tunnel	70,000 c. y.	6.50	8.50	6.00
22. Enlargements of tunnel	1,500 c. y.	6.50	10.00	6.00
23. Protect. coatings, cement mortar	500 c. y.	18.00	20.00	20.00
24. Str. steel support in tunnel	1,000,000 lb.	.07	.07	.08
25. Timbering in tunnel	100 Mbm.	125.00	120.00	110.00
26. Dry packing	500 c. y.	6.00	12.00	8.00
27. Drainage channels, tunnel	1,750 l. f. tun.	6.00	15.00	25.00
28. Forms for masonry lining, tun.	1,650 l. f. lin.	73.50	30.00	75.00
29. Conc. masonry in tunnel	17,300 c. y.	7.50	7.00	7.00
30. Excess conc. masonry, tunnel	4,000 c. y.	5.00	5.00	5.00
31. Drill holes, rock or masonry	2,500 l. f.	1.00	1.50	.60
32. Steel pipes for grouting	1,000 l. f.	1.00	1.00	.60
33. Make connect. for grouting	250 ea.	5.00	5.00	2.50
34. Sand for filters, grout and cem. mortar protect. coatings	1,400 c. y.	3.20	4.00	3.50
35. Mix and place grout	1,800 c. y.	10.55	15.00	13.00
36. Test borings	10,000 l. f.	4.00	5.00	4.00
37. Well drilling	700 l. f.	11.60	13.00	15.00
38. Portland cement	100,000 bbl.	2.40	2.10	2.50
39. Furn., place well points	500 l. f.	7.25	15.00	10.00
40. Pumping from tunnel, cut-off trench and caissons	80,000 Mil. ft. gal.	.30	.40	.10
41. Pumping from deep wells	50,000 Mil. ft. gal.	.20	.40	.10
42. Cr. stone and gravel	600 c. y.	5.00	4.00	5.00
43. Misc. metal-work	90,000 lb.	.20	.15	.20
44. Steel pipe and fittings	220,000 lb.	.11	.14	.10
45. Cast iron pipe and fittings	55,000 lb.	.08	.11	.20
46. Vitrified pipe	15,000 l. f.	.50	1.75	.75
47. Chlorinators	4 ea.	2,500.00	5,000.00	3,000.00
48. Liquid chlorine	8,000 lb.	.06	.10	.10
49. Engineer's offices	2,600 s. f.	13.25	15.00	10.00
50. Stream control dur. constr.	L.S.	12,000.00	10,000.00	5,000.00
51. Sanitary services	L.S.	43,500.00	20,000.00	15,000.00
52. Cleaning up	L.S.	4,000.00	10,000.00	10,000.00

BRICK STREET
DETROIT, MICHIGAN

OWNER: Michigan State Highway Dept., Lansing; Jack McCarthy, district engr.

PROJECT: Construction of 0.542 mi. of vitrified paving brick surfacing on concrete base on U. S. 112, Michigan Ave., from 29th St. to West Boulevard in Detroit, Mich. Includes all necessary grading and drainage structures, and removal of existing pavement, sidewalks, railway track and masonry and concrete structures.

CONDITIONS: Contractor to furnish all materials and complete work by July 1, 1941. Highway transportation facilities available. There is possibility of being held up on account of care which must be taken to protect existing public utilities. Wage rates specified are: skilled labor, $1.50 to $1.62½ per hr.; semi-skilled, 90 to 92½c. per hr.; and the common labor rate, 80c. per hr.

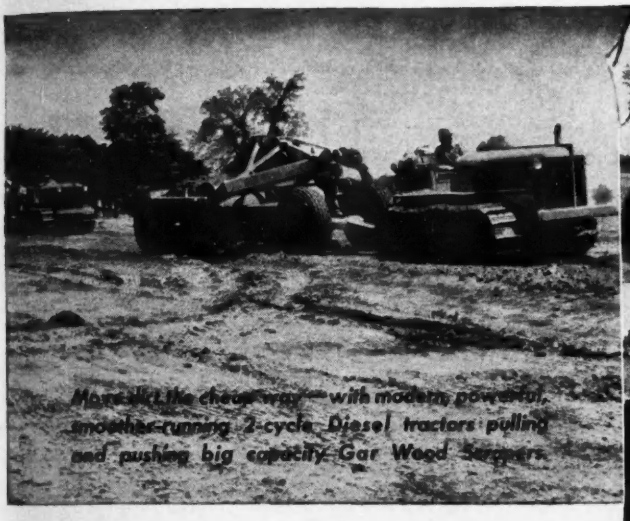
BIDS: Three bids were opened February 11, 1941, ranging from the contract low of $73,777 to $82,333.

LIST OF BIDDERS:

1. Julius Porath, Detroit, Mich. (contract) $73,777
2. Thomas E. Currie Co., Detroit, Mich. 80,041
3. Cooke Contracting Co., Detroit, Mich. 82,333

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Remove old pavement	2,093 s. y.	$0.40	$0.35	$0.40
2. Remove sidewalk	974 s. y.	.15	.30	.25
3. Remove masonry and conc	120 c. y.	3.50	5.00	5.00
4. Remove railway track	1,296 l. f.	.70	1.00	1.00
5. Earth excavation	1,607 c. y.	.65	1.00	.75
6. Sand, gravel fill (loose meas.)	1,958 c. y.	.70	.75	.75
7. Grade A concrete	13.7 c. y.	17.00	40.00	20.00
8. Steel reinforcement	2,827 lb.	.06	.10	.06
9. 12-in. sewer	328 l. f.	1.50	2.50	2.00
10. Manholes, type 1-A	2 ea.	100.00	100.00	100.00
11. Catch basins, type 3-B	4 ea.	80.00	90.00	100.00
12. Catch basin traps	4 ea.	25.00	25.00	25.00
13. Conc. base crse., 10–14–10-in.	12,013.6 s. y.	1.80	1.90	2.00
14. Conc. base crse., 10-in. uniform	350.7 s. y.	1.75	2.50	2.00
15. Conc. pavement, 9-in. uniform	117 s. y.	1.70	2.00	1.95
16. Conc. pavement, 7-in. uniform	60.6 s. y.	1.65	1.90	1.90
17. Pavement reinforcement	12,364.3 s. y.	.18	.20	.22
18. Vitrified brick surf. course	12,587.5 s. y.	2.60	2.65	2.77
19. Sheet asph. wearing course	26.96 ton	10.00	15.00	12.00
20. Asphaltic binder	19.73 ton	8.00	10.00	10.00
21. Conc. curb (det. 1)	45 l. f.	1.00	1.00	1.00
22. Conc. curb (det. 2)	448 l. f.	1.00	1.00	1.00
23. Conc. curb (det. 2A)	66 l. f.	1.00	1.25	1.00
24. Conc. curb (det. 3)	2,437 l. f.	1.15	1.25	1.25
25. Conc. curb (det. 3A)	35 l. f.	1.10	1.35	1.25
26. Conc. curb (det. A)	43 l. f.	3.50	2.00	3.00
27. Conc. driveway return (det. 15)	90 l. f.	1.25	2.00	1.50
28. Conc. driveway return (det. 18)	138 l. f.	1.25	2.00	1.50
29. Concrete end header (det. 20)	43 l. f.	1.00	.50	1.00
30. 4-in. concrete sidewalk	1,134 s. f.	.16	.18	.20
31. 6-in. concrete sidewalk	26,666 s. f.	.165	.20	.23
32. 7-in. concrete sidewalk	1,085 s. f.	.19	.30	.25
33. Ornamental hand rail	198 l. f.	2.50	3.00	3.00
34. Ornamental iron fence	42.5 l. f.	8.00	8.00	5.00
35. 18-in. concrete gutter	66 l. f.	1.25	2.00	1.00
36. Seal lamp post bases	18 ea.	2.00	5.00	2.00

Help yourself to a BIG YEAR



More dirt the cheap way — with modern, powerful, smoother-running 2-cycle Diesel tractors pulling and pushing big capacity Gar Wood Scrapers.

Handle more heavy grading and construction hourly, at less cost, with the more flexible Leaning Frame Grader and with the extra-earth moving capacity of the NEW Model A-D Motor Grader.

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Smooth out hauling roads... keep finished work in shape with this low cost W-Speed Patrol. Ideal for light grading and maintenance!

Get Them While They're Hot! Don't Let Old Equipment Hold You Back . . . Modernize Now With A-C Cost-Cutting Pacemakers!

The Construction job ahead almost staggers the senses. Too big to visualize—we only know there's plenty of work to be done . . . and to be done now. Already . . . first eight weeks of 1941 public construction awards top corresponding 1940 period by 123%.* If you aren't getting your share, check up on your equipment. Now is no time to drift! Let your Allis-Chalmers dealer streamline your outfit. He has today's tools . . . to handle today's work—a modern, complete line to fill any dirt-moving need. See him . . . NOW.

* Engineering News-Record Weekly Report—2-20-41

ALLIS-CHALMERS POWER

TRACTOR DIVISION—MILWAUKEE, U.S.A.

TRACTORS, ENGINES, ROAD MACHINERY

IT DOESN'T COST . . it Pays!

MATERIALS AND LABOR PRICES

Market quotations on construction materials and wage rates reported monthly by ENR correspondents

INCREASES in wage rates for both common and skilled labor provide the most important price changes for April. In Cleveland, bricklayers' and carpenters' rates rose 12½c. per hour, structural ironworkers hourly rate is 25c. higher, and common labor both on buildings and on heavy construction climbed 10c. per hour. In Seattle bricklayers are up 5c.; carpenters, 10c.; structural ironworkers and plasterers are each up 5c. per hour; common labor on buildings gained 5c.; and common labor on heavy construction rose 10c. In Birmingham, labor rates were mixed. Structural ironworkers' rate climbed 12½c. and plasterers' rate rose 25c. per hour, but the bricklayers' rate which was formerly $1.50 now ranges from $1.25 to $1.50, and the carpenters, formerly $1.12½, now range from $1.00 to $1.12½. The common labor rate on heavy construction in New York is 95c. per hour on all work bid after April 1, and will rise to that figure on all jobs after June 1.

Roofing supplies' prices increased in Philadelphia and New York but are lower in Cleveland, Minneapolis and St. Louis. Red lead advanced 25c. per 100-lb. in all 20 cities.

Ready-mixed concrete is up 25c. per cu.yd. in St. Louis, and paving asphalt climbed 95c. per ton in Detroit. Lumber prices revealed only minor changes, showing losses in pine in Kansas City, New York, St. Louis and Chicago, but an increase on some sizes in Cleveland.

Structural steel is 15c. per 100-lb. higher in San Francisco, the only change in the 20 cities. Reinforcing bars are up 5c. per 100-lb. in Cincinnati.

CEMENT, AGGREGATES, READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT			SAND AND GRAVEL			CRUSHED STONE		CRUSHED SLAG		CONCRETE
	Per bbl., carload lots, including 40c per bbl. for bags, cash discount not deducted			Per ton, carload lots			Per ton, carload lots		Per ton, carload lots, f.o.b. plant		Ready Mixed 1:2:4, 50 c.y. or more, delivered
	Cloth Bags *a*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.90	$2.66	$2.61	$1.75	$1.85	$1.95	$1.75	$1.85	$1.55	$1.65	$7.90
Baltimore	2.36	2.11	1.91	1.75‡	1.75‡	1.25‡	1.75‡	1.75‡	1.75‡	1.75‡	6.75
Birmingham	2.50	2.25	2.05	1.75	1.75	1.50	1.00	1.00	.90	1.15	5.80
Boston	2.75*b*	2.50*b*	2.30	1.20‡	1.20‡	.90‡	1.20‡	1.20‡	....	....	6.75*m*
Chicago	2.60	2.35	2.20	2.00‡*d*	2.00‡*d*	2.00‡*d*	2.00‡*d*	2.00‡*d*	1.25‡	1.25‡	....
Cincinnati	2.31	2.06	1.81	1.20	1.20	1.10	1.80	1.80	....	....	6.30
Cleveland	2.60	1.75	....	1.45*i*	1.45*i*	1.30*i*	1.70*i*	1.70*i*	1.70*i*	1.70*i*	6.55*i*
Dallas	2.47	2.22	2.02	1.75*p*	2.00*p*	1.25*p*	1.69*p*	1.84*p*	....	....	6.20
Denver	3.08	2.83	....	1.20	1.40	.90	....	....	....	....	7.25
Detroit	2.24	1.99	1.79	1.55	1.65	.95	1.55	1.65	1.30‡	1.40‡	6.50
Kansas City	2.56	2.31	2.16	1.85	2.30	1.00	1.91	1.91	....	....	7.25*n*
Los Angeles	2.25*b*	2.05*b*	....	1.00	1.00	1.00	1.00*f*	1.00*f*	....	....	5.85
Minneapolis	2.90	2.65	....	1.00*h*	1.00*h*	.25*h*	1.00*h*	1.00*h*	....	....	7.60*j*
Montreal	....	1.82*r*	1.67*r*	....	....	1.25‡	.85‡*c*	1.00‡*c*	....	....	6.45*l*
New Orleans	2.41	2.16	1.96	1.50	1.50	1.25	....	....	....	....	7.25
New York	2.55‡	2.30‡	....	1.25*de*	1.25*de*	.75*de*	1.65*de*	1.75*de*	....	....	6.50
Philadelphia	2.32	2.07	1.87	1.55‡	1.65‡	1.25‡	....	....	1.00	1.00	7.95*k*
Pittsburgh	2.44	2.19	1.99	1.40‡	1.40‡	1.70‡	2.25‡	2.25‡	1.50	1.50	7.50
St. Louis	2.55	2.30	....	1.50‡	1.50‡	1.25/1.50‡	1.00*h*	1.00*h*	.75*g*	.75*g*	7.75
San Francisco	2.16	1.96	1.66	1.36	1.36	1.36	1.46	1.46	....	....	6.95
Seattle	2.95*o*	2.70*o*	....	1.00*o*	1.00*o*	1.00*o*	2.00*o*	2.00*o*	....	....	7.25

‡ Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off for cash. *c* Plus municipal tax. *d* Per cu. yd. *e* Barge lots alongside docks. *f* Crushed granite. *g* F.o.b. Granite City, Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000. *l* Up to 200 cu. yd. *m* 50c. off for cash. *n* 25 c.y. or more. *o* 2% off for cash. *p* 10c. per ton off, cash 15 days. *r* 10c. per bbl. off, cash 20 days.

CASH DISCOUNTS CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl. for payment within 15 days of date of invoice. Subject discount 10c per bbl. 20 days in Montreal.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind.	$1.70	$1.65	Ironton, Ohio	$1.60	$1.55	Richard City, Tenn.	$1.80	$1.75
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind.	1.70	1.65	Steelton, Minn.	1.80	1.75
Hannibal, Mo.	1.70	1.65	Norfolk, Va.	1.65	1.60	Universal, Pa.	1.65	1.60
Hudson, N. Y.	1.75	1.70	Northampton, Pa.	1.55	1.50	Waco, Tex. (5c. tax in Tex.)	1.75	1.70
Independence, Kans.	1.70	1.65	North Birmingham, Ala.	1.70	1.65	Montreal	1.55	1.55

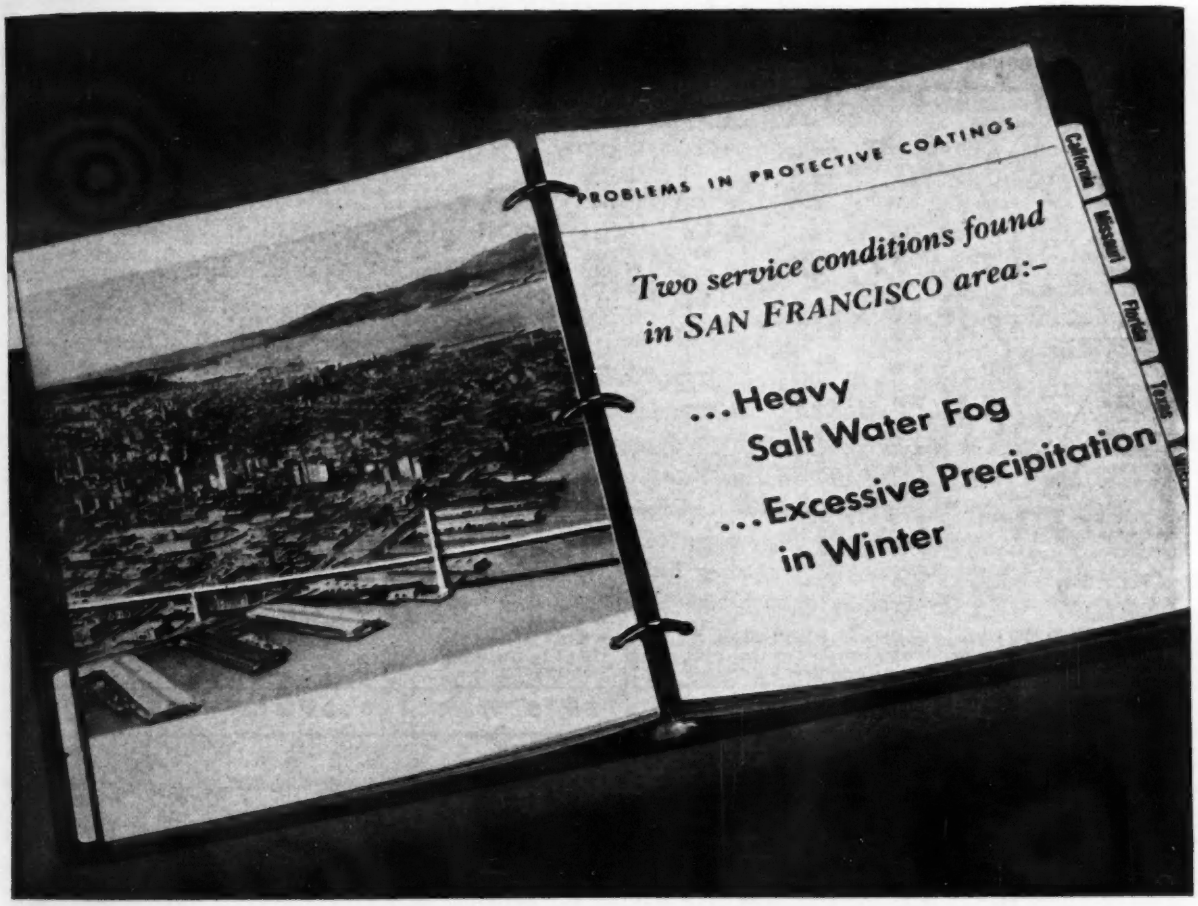
PAVING BRICK, BLOCKS, ASPHALT, ROAD OILS—F.O.B. CITY

	PAVING BRICKS AND BLOCKS			PAVING ASPHALT		ASPHALT BINDERS—FLUXES		CUTBACK ASPHALT		ROAD OILS	ASPHALT EMULSION (Quick-breaking)
	Granite per M. lots of 50,000 4x4x8 in.	Brick per M. 3"x4x8½ in. carload lots	Wood per sq. yd. 3½ in. 16-lb. treat	Per ton, less than 80 penetration		Per gal., 80-300 penetration		Per ton		Per gal.	Per gal.
				Tank car	Drums	Tank car	Drums	Tank car	Drums	Tank car	Tank car	Drums
Atlanta	$73.00	$39.35	$2.25	$17.30*e*	$23.83*e*	$0.0695*e*	$0.1018*e*	$0.0734*he*	$0.1257*h*	$0.0634*e*	$0.0734	$0.1257
Baltimore	160.00‡	45.00‡	2.75	14.00	20.00	.06	.09	.065*h*	.115*h*	.....	.....	.....
Birmingham	.....	27.50*f*‡	....	18.20	23.20	.0747	.1047	.0834*h*	.1484*h*	.....	.....	.....
Boston	85.00	47.50	3.00	14.00	20.00	.06	.09	.065*h*	.115*h*	.065	.09‡	.12‡
Chicago	135.00	45.00	1.85*d*	14.50	18.50	13.00*g*	17.00*g*	.06*h*	.10*h*	.04	.09	.125
Cincinnati	112.00	37.50	....	13.50	17.50	.07	.....	16.80	.....	.0525	.....	.075
Cleveland	110.00	37.50	2.25	15.00	20.00	.065	.075	.075*h*	.085*h*	.035	.08	.09
Dallas	.....	30.00	....	13.25	20.30	.06	.103	15.00	24.80	.055	.05/.07	.07/.09
Denver	.....	27.50	....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Detroit	.....	35.00	....	14.10*f*	19.00*f*	.061	.1025	14.10	18.60	.0475	.0645	.098
Kansas City	.....	40.00	....	18.50	23.50	.077	.1075	.077*h*	.107*h*	.057	.11	.15
Los Angeles	.....	50.00	....	6.50*b*	15.00	6.50*bg*	15.00*g*	5.50*b*	.....	.0192	.0525	.1125
Minneapolis	.....	.....	1.90*d*	19.20	24.20	.10	.12	19.30	28.30	.056	.....	.....
Montreal	75.00	.....	3.62	16.60	24.25	.116	.1483	.115*h*	.135*h*	.08	.135	.188
New Orleans	.....	.....	....	14.00*a*	19.00*a*	.055	.085	.06*h*	.09*h*	.....	.078	.....
New York	.....	.....	2.90	15.00	21.00	.06	.09	.065*h*	.115*h*	.....	.07	.11
Philadelphia	120.00	42.50	2.84	14.00	20.00	.055	.095	.06*h*	.10*h*	.05	.06	.10
Pittsburgh	135.00	38.75	....	.....	.....	.....	.....	.....	.....	.....	.....	.....
St. Louis	110.00/121.00	37.00	....	14.00	19.00	14.00*g*	19.00*g*	.06*h*	.095*h*	.04	.09	.125
San Francisco	.....	70.00	....	6.50	15.00	6.50*g*	15.00*g*	7.00	17.50	.025	.0525	.1125
Seattle	.....	60.00*c*	....	15.70	24.10	.....	24.10*g*	10.50/11.50	24.00/25.00	8.75*g*	.0575*i*	.1308*i*

‡ Delivered. *a* F.o.b. Baton Rouge. *b* Delivered to purchaser's warehouse. *c* 3½x4x8½ in. *d* 2½ in. 6 to 8-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *f* Mexican. *g* Per ton. *h* Per gallon. *i* F.o.b. Martinez. *j* 3x3⅝x8½ in.

ANOTHER PAGE IN THE STORY OF "BAKELITE" RESIN COATINGS

and how they meet rigid government and industrial specifications the country over



For example, in San Francisco:

Situated on a peninsula and surrounded by the waters of the Pacific Ocean on one side and by the Bay on the other, San Francisco typifies localities where exterior coatings protecting steel structures are continually exposed to the attack of salt water fog, and excessive precipitation during the rainy season.

To provide lasting protection under these and other severe service conditions, BAKELITE Laboratories have formulated, with the cooperation of leading paint and varnish makers, exterior coatings of unusual durability. Fortified with BAKELITE Resins, these coatings possess exceptional resistance to moisture, alkalies, and acids, and meet the stringent requirements of government authorities and industrial specifications. They assure long-lasting, economical service on steel and other surfaces subjected to the destructive action of smoke, fly-ash, acid gases, fumes, and widely varying extremes in temperature.

If you are faced with a problem in protective coatings, BAKELITE Laboratories will welcome the opportunity to assist in formulating specifications to meet your particular needs. Write for Booklet No. 11S, "BAKELITE Synthetic Resins," and Technical Bulletin No. 17, "Specifications for BAKELITE Resin Finishes."

BAKELITE CORPORATION, 30 EAST 42ND ST., NEW YORK
Unit of Union Carbide and Carbon Corporation

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Resins for Protective Coatings

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ¼-in.b billet b	RIVETS ½-in. struc-tural	WIRE NAILS Base d	SHEET PILING Base	STEEL RAILS Per Gross Ton Standard	Light	Re-rolled	TRACK SUPPLIES Angle Bars	Std. Spikes c	Tie Plates c	Track Bolts
Birmingham	$2.10	$2.15	$3.40	$2.55	.....	$40.00	$40.00	$39.00	$2.70	$3.00	$2.15	$4.15
Chicago	2.10	2.15	3.40	2.55	$2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Pittsburgh	2.10	2.15	3.40	2.55	2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Buffalo	2.10	2.15	.....	.....	2.40	.....	.....	.....	.....	.....	2.15	.....
Cleveland	2.10	2.15	3.40	2.55	.....	.....	.....	.....	.....	.....	.....	.....
Youngstown	.....	2.15	.....	.....	.....	.....	.....	.....	.....	3.00	.....	.....
Detroit	.....	2.25‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Gulf ports	2.45a	2.50a	.....	.....	2.85a	.....	.....	.....	.....	.....	.....	.....
Pacific ports	2.75a	2.55a	.....	.....	2.95a	.....	.....	.....	.....	.....	2.30	.....

‡ Delivered. a F.o.b. cars dock. b Rail steel same as billet prices. c Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates, alone, Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. d Add switching charge $18 per c.l.

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

	STRUCTURAL SHAPES Per 100 lb. base price	REINFORCING BARS*—Per 100 lb., ¼ in., base price 15 tons or over b New billet	Rail steel	Add Switch	$/cwt. for Del.	EXPANDED METAL LATH—Per 100 sq.yd.. carload lots— Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING—Per 100 s.f.. carload lots— 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in. No. 6 & 6 wires Per sq. yd.	SHEET PILING Per 100 lb. base price
Atlanta	$2.34	$2.39	$2.30	.02½	.10	$21.00	$23.00	$1.82	$1.35	$0.1719	$3.04
Baltimore	3.70	2.90	2.75	.....	.10	24.00	26.00	1.70	1.27	.1611	2.90
Birmingham	2.10a	2.15	2.15	.02½	.10	20.50	22.50	1.80	1.34	.1701	....
Boston	3.75	2.61	2.51	$20 C.L.	.10	15.50	17.50	1.76	1.31	.1656	2.77
Chicago	2.10a	2.15	2.05	.03	.05	20.00	22.00	1.67	1.25	.1575	2.40
Cincinnati	3.68	2.51cd	2.41cd	.....	.05	19.50	21.50	1.66	1.25	.1566	....
Cleveland	3.58g	2.15	2.15	.02½	.10	19.50	21.50	1.66	1.25	.1566	....
Dallas	4.90	3.80	3.80	.....	.....	22.50	24.50	1.93	1.42	.1827	....
Denver	4.35	3.95	3.80	.....	.....	23.50	25.50	1.97	1.45	.1863	....
Detroit	3.65‡	2.25	2.15	.....	.10	22.50	24.50	1.68	1.26	.1584	2.66
Kansas City	4.00	2.51cd	2.36cd	.0	.05	16.50	20.00	1.78	1.33	.1683	2.86
Los Angeles	3.65f	2.25	2.10	.02½	.05	23.00	27.50	1.93	1.42	.1827	3.65
Minneapolis	3.80‡	2.48c	2.48c	.0	.10	20.50/21.50	22.50/23.50	1.80	1.34	.1701	2.73d
Montreal	3.90	2.65	2.55	.....	.....	26.00h	33.00h	2.58	3.22	.264	2.58
New Orleans	4.40	2.52	2.52	.05	.10	21.50	23.50	1.82	1.35	.1719	2.875
New York	3.75	2.39	2.39	.....	.10	17.50	19.50	1.76	1.32	.1665	2.74
Philadelphia	3.55	2.66	2.56	.....	.....	19.50	21.50	1.71	1.28	.1611	2.72
Pittsburgh	2.10a	2.15	2.15	.02½	.10	21.50	24.50	1.59	1.20	.1503	2.40
St. Louis	3.69	2.39	2.39	.0	.05	24.50	28.50	1.69	1.27	.1602	2.70
San Francisco	3.90	2.50	2.35	.02½	.10	19.00	25.50	1.93	1.42	.1827	3.25
Seattle	2.75e	2.50e	.....	.....	.....	25.50	27.50	1.93	1.42	.1827	2.95e

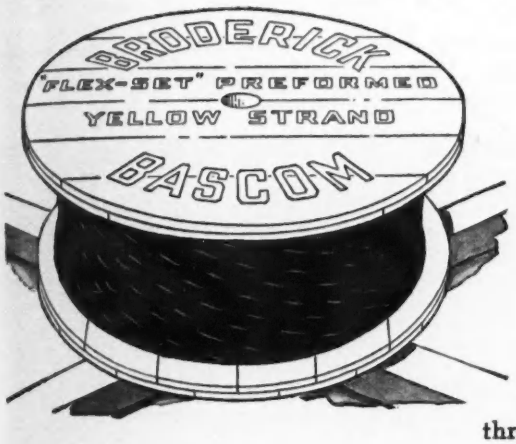
‡ Delivered. a Mill prices. b 5–15 tons, add 15c. 1–5 tons, add 25c. Less than 1 ton, add 50c. c 20 tons or over Base. d Mill price plus freight. e F.o.b. dock. f Includes delivery in free delivery zone. g Less than 1 ton, add 30c.; 1 to 5 tons, add 10c. High scrap steel prices cut former 15c. differences between new billet and rail steel in many mills. h List price.

PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE Per net ton f.o.b. 6 in. to 24 in.a	VITRIFIED SEWER PIPE Per foot, std. 8 in., s.s.	delivered std. 12 in., s.s.	ASTM 24 in.,	C13–35 36 in.,	CLAY DRAIN TILE Per 1,000 ft., carload lots, f.o.b. 6 in.	8 in.	CONCRETE SEWER PIPE Per ft., delivered; ASTM 12 in.	C 14–35 24 in.	WROUGHT STEEL PIPE Full standard weight, h 1 to 3 in., Black %	Butt Weld 3½ to 6in.; Galv. %	Lap Weld Black %	Galv. %
Atlanta	$49 40	$0.26b	$0.468bc	$1.8525	$4.68c	$85.00	$128.00	$0.45	$1.542	62.2	54.2	59.7	51.2
Baltimore	52.80	.40	.65	2.40	6.80	115.00	150.00	.60	1.90	65.5	57.5	63.00	54.5
Birmingham	45.00	.26	.468	1.7875	4.66	85.00	220.00	.40	1.60	62.2	54.2	59.7	51.2
Boston	55.00	.203	.4455	1.98	5.64	112.50‡	223.50‡	.45	1.69	64.1	56.1	61.6	53.1
Chicago	53.80	.28	.54	2.25	6.25	100.00‡	150.00‡	.38	1.48	67.0	59.0	63.5	55.0
Cincinnati	52.70	.196	.378	1.485	4.510	105.00	170.00	.60	1.70	65.9	57.9	63.4	54.9
Cleveland	54.24	.182	.351	1.395	4.305	69.00	108.00	.35	1.50	67.8	59.8	65.3	56.8
Dallas	58.20	.28	.504	2.016	4.70	80.00	100.00	.46	1.57	59.9	51.9	57.3	48.3
Denver	60.60	.24†	.52†	2.16†	.....	130.00	240.00	....	....	58.4	50.4	55.7	47.2
Detroit	54.24	.245	.4725	1.935	4.408	66.45	105.00	.33	1.50	66.3	58.3	63.8	55.3
Kansas City	55.12	.30	.54	2.16	5.00	120.00	240.00	.45	1.60	62.9	54.9	60.0	51.5
Los Angeles	55.00	.282†	.508†	2.034†	5.085†	115.50	192.50	1.00	2.00	59.6	51.6	57.0	48.6
Minneapolis	57.20	.24†	.432†	1.728†	4.60†	.....	.....	.70	1.80	64.2	56.2	60.7	52.2
Montreal	60.00	.55	.90	3.68	5.95e	135.00‡	260.00‡	.48	1.92	.....	.....	.....	....
New Orleans	51.38	.26	.48	1.69	.....	150.00	220.00	.37	2.10	62.4	54.4	58.8	50.3
New York	52.20	.35	.66	2.60	6.70	.....	.....	.50	1.20	64.9	56.8	62.4	53.9i
Philadelphia	50.90	.....	.....	.....	.....	.....	.....	.54	1.80	65.3	57.3	62.8	54.3
Pittsburgh	55.60	.245†	.4725†	1.845†	5.4325	97.80	154.20	.85g	2.00g	68.5i	60.5i	66.0i	57.5
St. Louis	52.48	.24	.432	1.728	3.96	85.00	170.00	.80j	2.00k	65.1	57.1	62.0	53.5
San Francisco	55.00	.3275d	.5895d	2.358	5.895	107.25	178.75	.54	2.50	57.6	49.2	54.8	46.0
Seattle	55.35	.35	.63	2.52	6.30	72.00	175.00	.35f	1.30f	.....	.....	.....	....

‡ Delivered. † F.o.b. a B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N.J. (base) $49.00. Gas pipe and class A, $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. b Double strength. c List to dealer. d List. e 30-inch. f Less 5% for cash. g Culvert pipe. h Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ¾ in., 8½c.; 1 in., 11½c.; 1¼ in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92. i Applies also at Lorain, Ohio, mills. Chicago delivered base is 2½ points less on butt, 1½ on lap. Freight is figured from Pittsburgh, Lorain, O., Chicago Dist. Billing is from point producing lowest price at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base: Butt-weld—1 in. and 1¼ in. black 34, galv. 19; 1½ in. black 38, galv. 21½; 2 in. black 37½, galv. 21. Lapweld—2½ in. to 3½ in. black 31½, galv. 17½ in.; 4½ in. to 8 in. black, 32½ galv. 20. j Reinforced; spec. C 76-37. k Reinforced; spec. C 75-37.

SCRAPER PROFITS OFTEN "HANG BY A ~~THREAD~~" *Cable*



GIVE YOUR PAY LOADS THE SUPPORT OF TIME-TESTED YELLOW STRAND

On tightly-figured jobs, profit or loss may hang, thread-like, on the single factor of *cable* performance. That's why it's important to specify, and to be sure you *get*, "Flex-Set" Preformed Yellow Strand to replace worn ropes on cable controlled machines.

Experience in the field has proved how Yellow Strand helps secure peak production out of today's efficient scrapers. Speedier loading . . . more yardage per unit . . . fewer stops for repairs or cable changes — these are savings you can logically count on because the cable has been specially engineered for service on your equipment.

Every foot of time-tested Yellow Strand has been expertly balanced to combine elasticity, toughness, strength. Starting with highest quality steel wire, drawn to our rigid specifications, it is fabricated by up-to-date mechanized methods that climax 65 years of *exclusive* wire rope manufacturing. Both the wire rope center and the cable itself are *preformed* to make a limber, smooth-running line that is non-kinking, safe to handle and highly resistant to fatigue.

When you order cable — when you *reorder* it — don't run the risk of disappointment. Stick to the rope with the yellow strand. It's ready and waiting for you now at your nearby distributor's store.

BRODERICK & BASCOM ROPE CO., ST. LOUIS

Branches: New York • Chicago • Houston • Portland • Seattle
Factories: St. Louis • Seattle • Peoria
Distributors in All Industrial Centers

"ONE AND ONLY"

Cost-wise contractors and operators have positive ideas about scraper cable. That so many demand Yellow Strand as their "one and only" rope proves there's no substitute for the demonstrated economy of this veteran road worker.

Next time install long-lived Yellow Strand as specially designed in size, length and construction for your machines. You can't find a better team mate for

ALL-PURPOSE SCRAPERS
'DOZERS • RIPPERS • CRANES
And All Other Cable Controlled Equipment

Replace **WORN CABLE WITH "FLEX-SET" PREFORMED YELLOW STRAND**

LUMBER, TIMBER, PLYWOOD—PER M FT., B.M., CARLOAD LOTS F.O.B.

	SHORT LEAF YELLOW PINE AND DOUGLAS FIR — All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face) — *All Fir planks No. 2 common, Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)*									LONG LEAF Y. P. Merchantable grade up to 20 ft.		PLYWOOD* Rail freight increment (See note for base price)	
	1x6 Sel	1x8 Sel	2x4 Sel	2x6 Sel	2x8 Sel	2x10 Sel	3x12 Sel	6x12 Sel	12x12 Sel	2x12 Sel	12x12 Sel	⅜"	3/8"
Atlanta	**$28.00**	**$28.00**	**$25.00**	**$26.50**	**$26.50**	**$29.50**	**$31.00**	.....	.....	$42.00	$55.00	$17.75	$21.60
Baltimore	**39.00**	**40.00**	**40.00**	**41.00**	**41.00**	**42.00**	**54.00**	.....	.....	78.00	80.00	17.35*g*	21.15*g*
	41.00	*41.00*	*43.00*	*43.00*	*43.00*	*43.00*	*54.00*	*$56.00*	*$56.00*	.....	.....	.....	.....
Birmingham	**27.00**	**27.00**	**26.00**	**26.00**	**26.00**	**29.00**	**45.00**	**45.00**	**52.00**	.....	.....	16.25	19.85
[1]	30.00	30.00	30.00	30.00	30.00	35.00	60.00	.....	.....	65.00	63.00	.....	.....
Boston	**38.00**[2]	**38.00**[2]	**40.00**[2]	**45.00**	**60.00**[1]	**65.00**[1]	**80.00**[1]	.....	.....	80.00	80.00	17.35*g*	21.15*g*
	38.00	*38.00*	*40.00*	*45.00*	*45.00*	*45.00*	*50.00*	*50.00*	*55.00*	.....	.....	.....	.....
Chicago	**42.00**	**42.00**	**38.00**	**38.00**	**38.00**	**42.00**	**51.00**	.....	.....	90.00	100.00	13.80	16.80
	40.00	*40.00*	*39.00*	*39.00*	*39.00*	*41.00*	*47.00*	*47.00*	*47.00*	.....	.....	.....	.....
Cincinnati	**37.50**	**39.00**	**38.00**	**38.00**	**38.00**	**41.00**	**50.00**	.....	.....	60.00	63.00	16.25	19.85
	.....	.....	.....	.....	.....	.....	*52.00*	*52.00*	*52.00*	.....	.....	.....	.....
Cleveland	**40.00**	**41.00**	**41.00**	**39.00**	**40.00**	**45.00**	**50.00**	50.00	50.00	83.00	83.00	16.70	20.40
Dallas *e*	**36.00**	**39.00**	**38.00**	**36.00**	**37.00**	**38.50**	**52.50**	**52.50**	**52.50**	76.00	81.00	13.90	16.95
Denver ‡	47.00[4]	46.00[4]	50.00[4]	50.00[4]	50.00[4]	52.00[4]	52.00[4]	62.00[4]	65.00[4]	.....	.....	9.90	12.05
Detroit	**42.50**	**42.50**	**41.00**	**42.50**	**42.50**	**44.50**	**51.00**	.....	.....	50.00	59.00	16.25	19.85
	.....	.....	.....	.....	.....	*49.00*	*52.00*	*59.00*	*59.00*	.....	.....	.....	.....
Kansas City	**40.00**	**40.00**	**37.00**	**37.00**	**37.00**	**40.00**	**45.00**	.....	.....	65.00	70.00	12.25	14.95
	42.50	*42.50*	*40.00*	*40.00*	*40.00*	*42.50*	*42.00*	*45.00*	*45.00*	.....	.....	.....	.....
Los Angeles *a*	*40.00*	*40.00*	*39.00*	*39.00*	*36.00*	*36.00*	*43.00*	*43.00*	*43.00*	.....	.....	9.35*gh*	11.35*gh*
Minneapolis ‡*b*	40.00[5]	40.00[5]	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.05	14.70
‡	*42.00*	*42.00*	*42.00*	*40.00*	*40.00*	*42.00*	*46.00*	*53.50*	*53.50*	.....	.....	.....	.....
Montreal [3]	*36.00*	*38.00*	*36.00*	*38.00*	*40.00*	46.00	.....	.....	.....	155.00	165.00	.....	.....
	53.50	*53.50*	*54.25*	*54.25*	*59.25*	*59.25*	*65.00*	*65.00*	*65.00*	.....	.....	.....	.....
New Orleans	**24.00**	**25.00**	**25.00**	**24.00**	**24.00**	**25.00**	**46.00**	.....	.....	62.00	69.00	13.90	16.95
	29.00	*29.00*	*28.00*	*33.00*	*35.00*	*34.00*	*36.00*	.....	.....	.....	.....	.....	.....
New York ‡	**45.00**	**46.00**	**43.00**	**43.00**	**44.00**	**46.00**	**48.00**	.....	.....	85.00*f*	90.00*f*	17.35*g*	21.15*g*
‡	.....	.....	*58.00*	*58.00*	*58.00*	*58.00*	*54.00*	*54.00*	*54.00*	.....	.....	.....	.....
Philadelphia	**24.00**	**24.50**	**25.50**	**25.50**	**27.50**	**27.50**	**29.00**	.....	.....	50.00	57.50	17.35*g*	.1512*g*
	35.00	*36.50*	*39.00*	*38.25*	*39.00*	*39.00*	*44.00*	*32.00*	*32.00*	.....	.....	.....	.....
Pittsburgh	**50.80**	**53.20**	**62.75**	**55.00**	**60.85**	**62.50**	**76.25**	.....	.....	.....	.....	17.00	20.70
	69.20	*68.10*	*66.10*	*62.30*	*65.20*	*65.65*	*88.75*	*88.75*	*88.75*	.....	.....	.....	.....
St. Louis ‡*c*	**40.00**	**41.00**	**39.00**	**38.00**	**39.00**	**40.00**	**52.00**	*58.00*	*58.00*	75.00	74.00	13.90	16.95
San Francisco *d*	*28.00*	*27.00*	*28.00*	*29.50*	*29.00*	*29.50*	*29.50*	*28.00*	*28.00*	.....	.....	7.30*g*	8.90*g*
Seattle	*27.00*	*27.00*	*27.00*	*27.00*	*27.00*	*27.00*	*36.00*	*36.00*	*36.00*	.....	.....	0.00	0.00

Bold Face type, Southern Pine. *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers' N. C. Pine. [3] Spruce. [4] Native. [5] Western Pine, No. 3 Common. [7] Spruce. [8] Norway Pine. ‡ Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* At ship's tackle. *e* 10% discount taken off. *f* Up to 18 ft.

NOTE: Special concrete form grade Fir Plywood, 4' by 8' panels, 5-ply, sanded 2 sides, water resistant glue, carload lots, delivered per 1,000 sq. ft. surface, Seattle base price on ⅜", $86.50; on ¾", $95.30; price includes oiling and sealing charges. For other centers add rail freight increment from table or proper size. For resin dipped treatment, add $10.50 per M. *Many mills out of market due to rush of defense orders. *g* Lower rate by water shipment. *h* 50,000 lb. minimum

GLASS, EXPLOSIVES, CHEMICALS

	WINDOW GLASS — Discounts from jobbers list, Aug. 15, 1938 Single or Double Thickness A quality	B quality	EXPLOSIVES — Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 200 lb. lots*
Atlanta	75%	75%	$0.15
Baltimore	82%	81%	.15
Birmingham	75%	75%	.105
Boston	78%	79%	.15
Chicago	79%	79%	.15
Cincinnati	77%	77%	.15
Cleveland	77%	77%	.19
Dallas	78%	78%	.1625
Denver	77%	77%	.155*e*
Detroit	79–10%	79–10%	.15
Kansas City	77–10%	77–10%	.155
Los Angeles	86%*d*	88%*d*	.1575
Minneapolis	76%	76%	.155
Montreal	40–10%	50–5%	.155†
New Orleans	70%	75%	.16
New York	81%	82%	.22*f*
Philadelphia	82–10%*d*	83–10%*d*	.15
Pittsburgh	79%	79%	.1225
St. Louis	77–10%	77–10%	.155
San Francisco	78%*d*	83%*d*	.155
Seattle	75%	76%	.1575†

Price of 60% Ammonia Gelatin is $0.015 per lb. higher than 40%

a Disc. from list Sept. 1939. *b* Also less 6% tax exemption. *d* Discount from jobbers' list Sept. 15, 1928.

* Urban prices influenced by service charges or local storage and delivery regulations, do not consistently reflect quantity prices in less congested areas. *e* F.o.b. Louviers, Colo. *f* In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal Street, add delivery charge of $6.00 per trip. † F.o.b.

40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)

	C/L 20,000 lb. net	Tons	200 lb. lots
E. of the Miss., except Fla	$0.105	$0.14	$0.16
W. of Miss. to Rocky Mtn. States, and Fla	.11 –.1175	.135 –.1475	.155 –.1675
Rocky Mtn. States	.105 –.1325	.125 –.1375‡	.135–.1525‡
Pacific N. W. States	.1075–.12	.1375–.15	.1575–.17
Pacific S. W. States	.1050–.1175	.135 –.1475	.155 –.1625

‡F.o.b. Louviers, Colo., or Butte, Mont.

PILES, TIES—F.O.B.

PILES

Prices per linear foot, pine, with bark on, f.o.b. New York; delivered from barge 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf — Barge	Short Leaf — Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.18	$0.195
12 in.— 2 ft. from butt	6 in.	50 to 59 ft.	.225	.24
12 in.— 2 ft. from butt	6 in.	60 to 69 ft.	.23	.255
14 in.— 2 ft. from butt	6 in.	50 to 69 ft.	.24	.265
14 in.— 2 ft. from butt	6 in.	70 to 79 ft.	.28	.275
14 in.— 2 ft. from butt	5 in.	80 to 85 ft.	.40	.415
14 in.— 2 ft. from butt	5 in.	85 to 89 ft.	.42	.482

RAILWAY TIES

Prices f.o.b., per tie for carload lots:		6"x8"x8' Untr.	6"x8"x8' Tr.	7"x9"x8'6" Untr.	7"x9"x8'6" Tr.
Boston	Oak	$1.20	....	$1.65	....
	Pine	1.50	$2.25*a*	2.25	$3.20*a*
New York	S. L. Sap Pine	1.20/1.30	1.95	1.60	2.45
	Mixed Oak	1.55	2.05	2.00	2.55
Birmingham	White Oak	.85	1.50*a*	1.35	1.70*a*
	Southern Pine	.55*b*	1.10*ab*	.70	1.30*a*
Chicago	Oak	....	1.65*a*	....	2.25*a*
	Southern Pine	....	1.53*a*	....	2.13*a*
Los Angeles	Douglas Fir	.64	1.38*a*	.90	1.80*a*
Philadelphia	Red Oak	1.10	....	....	2.40*a*
St. Louis	White Oak	1.25	....	1.65	....
	Red Oak	1.25	1.70*a*	1.65	2.25*a*
	Sap Pine or Cypress	1.15	....	1.55	....
San Francisco	Douglas Fir	1.00*bef*	....	....	2.45*ef*
Montreal	Birch or Maple	.65	1.05*a*	.75	1.35*a*

Tr.— Treated; Untr.— Untreated. *a* Creosoted. *b* 6" x 8" x 8'6". *e* Empty cell. *d* Zinc. *e* Green. *f* At ships tackle.

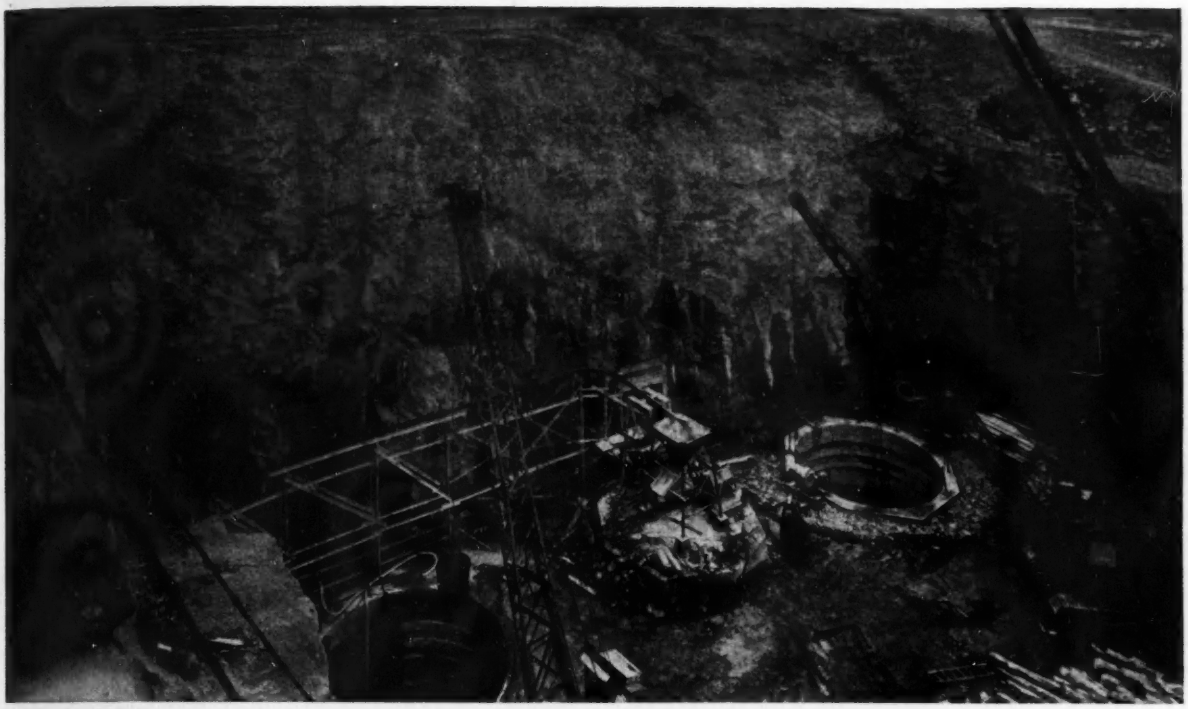
CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York

Bleaching powder, in drums, f.o.b. works, per 100-lb	$2.00–2.85
Chlorine cylinders, liquid, per lb. delivered	.0525
Calcium chloride, 77–80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, delivered, per ton	20.50–35.00
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb	1.40
Soda ash, 58%, in paper bags, per 100 lb. dense	1.10
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	23.00
Sulphate of copper, in bbl., per 100-lb	4.75

12 MILLION DOLLAR DELAWARE AQUEDUCT CONTRACT
Timken Bits USED 100% FROM START TO FINISH

View of effluent chamber excavation by Frazier-Davis showing a 15′ shaft downtake capped with concrete and flanked by two down pipe shafts.



The Frazier-Davis Construction Company of St. Louis was awarded contract #321 of the Delaware Aqueduct Project for $11,924,450. It included driving 11,900 feet of 13½′ tunnel, 23,100 feet of 15′ tunnel and the removal of 60,000 cubic yards of rock in an open cut.

TIMKEN Rock Bits drilled every foot of hole on this entire contract! Serious drilling started in June 1939. Using 4" automatic drifters and working 24 hours per day 5 days per week the last heading "holed thru" on Christmas Eve 1940.

The rock on this contract, granitic gneiss and quartz throughout, is generally acknowledged to be the hardest along the entire 85 miles of tunnel. Footage per TIMKEN Bit use varied from 6" to 2′ and the monthly variable average of uses per bit was between 3.32 and 5.45.

The fact that Frazier-Davis, one of America's foremost contractors, used TIMKEN Bits 100% on their 12 million dollar job proves that TIMKEN Bits really have "something". Write us, we'll be glad to show *you* what it is.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN
ROCK BITS

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE — PARTITION — SCORED Per M. lots of 2,000 pieces or over, 3x12x12 in.	4x12x12 in.	8x12x12 in.	STRUCTURAL CLAY TILE — LOAD BEARING — SCORED Per M. lots of 2,000 pieces or over, 8x12x12 in.	10x12x12 in.	12x12x12 in.	BRICK Per M. in quantity. Common backing	Straight hard	LIME Per ton, Hydrated finishing	In paper, Common hydrated	Carload lot, Pulverized or lump
Atlanta	$90.00	$100.00	$185.00	$220.00	$230.00	$240.00	$12.50	$17.00	$26.50	$17.00	$17.00
Baltimore	75.00	80.00	150.00	180.00	225.00	280.00	14.00k	17.00k	18.50	15.00	2.50m
Birmingham	80.00	85.00	160.00	191.00	252.00	288.00	14.00	17.00	18.11	12.64	1.66lo
Boston	98.70a	105.30a	206.85a	236.15	310.85a	346.10a	17.00i	20.00i	18.50	13.91	16.50l
Chicago	68.10	72.60	135.90	185.70	234.90	268.10	11.00	12.00	16.40	14.40	12.20
Cincinnati	61.40	65.30	121.90	141.50	187.30	215.20	16.00	16.00	15.40	13.00	.....
Cleveland	56.50	60.00	112.50	135.00	182.00	209.00	16.00	16.00	15.00j	12.00j	2.75jm
Dallas	50.00	52.00	100.00	135.00	200.00	250.00	11.50i	13.50i	19.00	15.00	.95n.
Denver	84.80	94.40	152.70	178.20	212.00	227.90	13.50	17.00	30.00j	19.00j	30.00j
Detroit	69.00	73.60	138.00	176.00	232.00	265.00e	16.00	17.00	16.00	13.75	14.75
Kansas City	64.50	66.50	86.00c	125.50	159.75	186.25	14.50	24.00	19.10	12.80	10.70
Los Angeles	73.50†r	89.50†r	128.00c†r	210.00†r	368.00†r	460.00†r	13.50	15.00	16.50	17.50	17.50
Minneapolis	71.45	76.20	143.95	171.45	173.80	242.10	13.10	15.10g	21.00	16.00	19.00
Montreal	72.20a	77.50a	142.50a	76.00at	165.80a	248.70	17.50†	24.25†	23.50	17.00	12.00
New Orleans	72.00	72.00	135.00	162.00	210.00	260.00	14.00	.....	18.30	12.08	14.10
New York	87.00	93.00	128.00c	193.30h	238.80h	295.60h	13.00	.....	19.00	14.00	17.00
Philadelphia	80.50	85.90	161.10	193.30	238.80	295.60	16.00s	18.00s	15.70q	10.05q	12.05q
Pittsburgh	58.40	62.40	116.85	124.00	153.00	193.75	17.00	25.00	17.90	15.40	2.55m
St. Louis	62.00	88.00	120.00	180.00	234.00	280.00	16.00	17.00	22.00	16.00	2.30lm
San Francisco	84.00	94.50	225.00	.....	.....	.....	14.00	17.00	.75o	2.05o	16.40
Seattle	100.00	110.00	220.00	.....	.....	.....	18.00f	22.00f	20.00s	20.00s	20.00s

† F.o.b. a Smooth. b Carload lots delivered to job. c 6x12x12 in. d Not load bearing. e 48 lb. tile. f Less $1.00, ½ cash 15 days, balance 30 days. g Selected common. h F.o.b. Perth Amboy, N. J. i 50c. per M. off for cash. j LCL. k $1.00 discount if paid in 10 days. l Lump. m Per bbl., 180 lb net. n Per sack 100 lb. o Per bbl., 200 lb. p 280 lb. bag. q 25-ton cars. r 5% discount 10 days. s 2% off cash. t 5½ x 8 x 12.

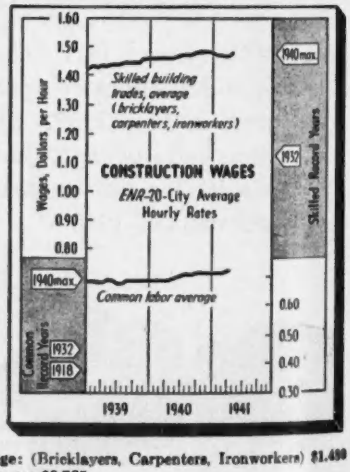
PAINT, ROOFING—F.O.B. CARLOAD LOTS

	RED LEAD Per 100 lb. in 600-lb. (Approx.) bbl. Dry a	WHITE LEAD Per 100 lb. in oil	READY-MIXED PAINT Per gal., drums Graphite b	Aluminum c	Ferric Oxide d	ROOFING SUPPLIES Carload lots f.o.b. factory Rolls, slate surfaced, 85-90 lb. per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating per gal.	Tar pitch 350 lb. bbl. per ton
Atlanta	$9.50	$13.125	$1.30	$2.25	$1.20	$1.90	$1.61	$1.61	$0.27	$29.00
Baltimore	9.25	12.75	1.75	2.50	2.00	2.50	3.00	3.00	.60	2.30m
Birmingham	9.50	13.125	2.35	2.75	1.85	1.98	1.57	1.57	.32	27.00
Boston	9.25	12.75	1.85‡	2.50‡	1.80‡	1.96‡	1.85h‡	1.85h‡	.50‡	20.00‡
Chicago	9.25	12.75	2.10	2.63	1.72	1.45hf	1.50hf	1.50hf	.26f	22.00f
Cincinnati	9.25	12.75	1.65	2.85	1.55	2.40	2.39h	2.39h	.36	21.00
Cleveland	9.25	12.75	1.90	2.60	1.60	1.66	1.42h	1.42h	.34	21.00
Dallas	9.25	13.50	1.88	2.11	....	2.50h	2.60h	2.70h	.50	34.00
Denver	9.75	13.25	1.65	2.40	.17i	2.45	4.00	3.00	.35	28.00
Detroit	9.25	12.75	1.75	2.75	1.25	2.40	2.50	2.50	.35	26.00
Kansas City	9.25	12.875	2.15g	2.40g	1.67g	1.93	2.09	2.09	.25	25.00
Los Angeles	9.50	13.25	1.60	2.25	2.30	2.10	1.50	....	.45	.....
Minneapolis	9.25	12.875	....	....	....	1.66i	1.42hi	1.42hi	.29	21.00
Montreal	9.25	9.00	2.40	2.97	2.51	2.64	1.85	1.86	.63	1.85k
New York	9.25	12.75	2.02	2.55	1.64	1.83	1.58h	1.58h	.23	24.00
Philadelphia	9.25	12.75	....	....	....	2.27e	1.94he	1.94he	.41e	22.00
Pittsburgh	9.25	12.75	1.05	1.95	.80	1.95	1.94h	1.94h	.34	26.00
St. Louis	9.25	12.75	1.90/2.00	2.60/2.80	1.60/2.00	1.68	1.42	1.42	.27	21.00
San Francisco	9.50	13.00	1.80	2.75	1.10/2.00	1.65	2.26	2.26	.28	17.00
Seattle	9.50	13.25	1.80	2.60	....	1.81	1.18h	1.75	.35	28.00j

‡ Delivered. Note: Red lead in oil 50c. higher than white lead in oil prices. a Red lead prices change frequently due to pig lead price changes. b U. S. War Dept. Spec. 3-49A. c ASTM Spec. D266-31. d 80% minimum ferric oxide. e Subject to 25% discount. f Distributors' price to contractors. g 5 gal. can. h Per roll, 65 lb. i Minneapolis and vicinity. j Asphalt pitch. k Per 100 lb. l Per lb. * per bbl.

SKILLED AND COMMON WAGE RATES—PER HOUR

	Bricklayers	Carpenters	Struct. Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const.
Atlanta	$1.25	$1.00	$1.375	$1.00/1.25	$1.25	$0.40/.50	$0.40/.50
Baltimore	1.50	1.25	1.65	1.50	1.375	.625	.625
Birmingham	1.25	1.00	1.50	1.00/1.125	1.25	.40	.40
Boston	1.50	1.25	1.50	1.625	1.625	.60/.85	.60/.85
Chicago	1.70	1.625	1.70	1.70	1.70	1.025	1.025]
Cincinnati	1.625	1.45	1.55	1.375/1.525	1.625	.75	.75
Cleveland	1.75	1.50	1.75	1.50/1.75	1.625	1.00	1.00
Dallas	1.50	1.00	1.25	1.00	1.50	.40/.50	.40/.50
Denver	1.65b	1.43b	1.43b	1.43b	1.50b	.718b	.718b
Detroit	1.50	1.25	1.625	1.50	1.55	.65/.75	.60/.775
Kansas City	1.625	1.375	1.50	1.50	1.575	.85	.50
Los Angeles	1.25	1.10	1.375	1.375	1.50	.625	.625
Minneapolis	1.375	1.25d	1.50	1.40	1.50e	.85	.85
New Orleans	1.50	1.25	1.375	1.375	1.40	.40	.50
New York	2.00b	1.85b	2.00	2.00b	2.00c	1.031	.875/.95f
Philadelphia	1.65b	1.40	1.65	1.50	1.75	.70	.70
Pittsburgh	1.75	1.50	1.50	1.25	1.75	.80	.70
St. Louis	1.25/1.50	1.00/1.50	1.75	1.50/2.00	1.25/1.75	.675/.875	.875
San Francisco	1.75c	1.25	1.60	1.50	1.60c	.85/.875	.813
Seattle	1.65	1.35	1.55	1.50	1.65	.95	1.00
Montreal	.80	.70	.75	.65	.80	.45	.40



b 7 hr. day. c 6 hr. day. d 35 hr. wk. e 30 hr. wk. f 95c after June 1.

ENR Skilled Average: (Bricklayers, Carpenters, Ironworkers) **$1.490**
ENR Common Average: $0.725